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**U.S. Army
Environmental
Center**

**FORT DIX
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
FOR 13 SITES**

**FINAL TECHNICAL PLAN
DATA ITEM A004**

**CONTRACT NO. DAAA15-91-D-0008
TASK ORDER 0006**

**U.S. Army Environmental Center
Aberdeen Proving Ground, Maryland**

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SEPTEMBER 1995

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**FINAL TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES**

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1.0 INTRODUCTION

1 The United States Army has tasked ABB Environmental Services, Inc. (ABB-ES) to
2 prepare project plans for conducting Remedial Investigations/Feasibility Studies
3 (RIs/FSs) for 13 Sites at the Fort Dix Army Installation (Ft. Dix), located in central
4 New Jersey (Figure 1). Work for this assignment will be performed under Contract
5 No. DAAA15-91-D-0008, Task Order 6.

6
7 In accordance with the requirements of this task, a RI/FS Technical Plan, Quality
8 Assurance Project Plan (QAPP), and a Health and Safety Plan (HASP) are included
9 with this submittal. The work plans prepared for this task order are based on:

- 10 a. The objectives of preparing project plans for conduct of a RI/FS at the
11 13 Sites listed in Subsection 1.1;
- 12 b. Evaluation of background information on Ft. Dix provided by the
13 United States Army Environmental Center (USAEC);
- 14 c. Verbal communications with USAEC and Ft. Dix personnel;
- 15 d. Results of a August 17 - August 19, 1993 site visit by ABB-ES; and
- 16 e. Information derived during a meeting with representatives of USAEC,
17 Ft. Dix, U.S. Environmental Protection Agency (USEPA), and New
18 Jersey Department of Environmental Protection (NJDEP) on
19 September 28, 1993.

20
21 This Technical Plan summarizes existing data and background information currently
22 available on the 13 Sites and provides a detailed discussion of the scope of
23 investigative activities planned for the RIs at the 13 Sites as well as a discussion of
24 the programs that will support the investigation (e.g., Quality Assurance/Quality
25 Control [QA/QC], Health and Safety, Data Management). The following paragraphs
26 address several issues which have shaped the development and structure of this
27 Technical Plan.

28
29 This Technical Plan is structured similar to the Work Plan and Sampling Design Plan
30 developed for the Ft. Dix Environmental Investigation/Alternatives Analysis (EI/AA)
31 (ICF, 1993) and the Technical Plan developed for the Ft. Dix RI/FS for the MAG-1

SECTION 1

1 Area (ABB-ES, 1994a). Data collected as a result of some sampling efforts
2 conducted in the Ft. Dix EI/AA and MAG-1 Area RI will be used in the
3 development of this RI including:

- 4 1. Background surface water, sediment, subsurface soil, and groundwater
5 samples collected near Brindle Lake (additional background samples
6 will be proposed as part of a base-wide Background Sampling
7 Program).
- 8 2. Surface water and sediment samples collected from Dogwood Lake
9 where this RI proposes additional work to characterize previously
10 detected total petroleum hydrocarbon (TPH) contamination in
11 groundwater in this area.

12 The investigations within this Technical Plan are being conducted under provisions
13 of the Comprehensive Environmental Response, Compensation, and Liability Act
14 (CERCLA), with the USEPA as lead agency. Several different protocols/
15 methodologies are presented in this RI to address fieldwork activities, laboratory
16 sample analyses, data validation, and performance of risk assessments. This
17 integration of different protocols/methodologies addresses issues and concerns raised
18 by the USAEC, USEPA, and NJDEP. In general, the most conservative protocols/
19 methodologies are utilized. The following is a list of agencies' protocols/
20 methodologies to be followed:

- 21 1. drilling permits - NJDEP;
- 22 2. borehole advancement/abandonment - NJDEP;
- 23 3. drilling materials - USAEC;
- 24 4. decontamination - USEPA;
- 25 5. QA\QC sampling - USEPA frequencies;
- 26 6. laboratory methodologies - USAEC (where available, otherwise
27 USEPA); at a minimum, the analysis will quantify Target Compound
28 List (TCL) volatile and semivolatile compounds and Target Analyte
29 List (TAL) metals and cyanide as appropriate;

SECTION 1

- 1 7. data validation - USAEC or USEPA depending on the laboratory
2 methodology used;
- 3 8. risk assessment - USEPA;
- 4 9. cleanup goals - USEPA risk based (NJDEP cleanup standards to be
5 used as to be considered [TBC] guidance).

6 Within this Technical Plan the number of explorations, their depths and sampling
7 frequencies are estimated for planning purposes. As this program utilizes extensive
8 field screening methods, it should be recognized that field modifications to the
9 estimated locations, depths, and sampling frequencies may need to be made as the
10 screening data becomes available. This will enhance the quality and comprehensive
11 nature of the RI.

12 This Technical Plan makes substantial use of field screening techniques to evaluate
13 contamination in the various media at Ft. Dix. Field screening analyses are outlined
14 in the QAPP including methodologies for VOCs, pesticides, petroleum hydrocarbons,
15 herbicides, and explosives. The objectives of the screening program include the
16 following:

- 17 • to provide real time on-site data to direct field investigations, select
18 monitoring well screen placement, and to aid in selection of samples
19 for off-site laboratory analysis;
- 20 • to provide USEPA Level II quantitative data on VOCs, pesticides, and
21 TPH which will be used in conjunction with off-site laboratory results
22 to evaluate contaminant distribution at the 13 sites;
- 23 • to provide data on the presence or absence of herbicides and
24 explosives at a subset of sites; and
- 25 • to be used as support data during the development future planning
26 documents including the RI and FS reports, No Further Action
27 documents, and RODs.

28 Field screening allows for relatively rapid data collection and analyses, although the
29 quality of the data is typically lower than that associated with laboratory analyses.
30 In accordance with the NJDEP Field Analysis Manual (NJDEP, 1994), this Technical
31 Plan will utilize field screening to support the RI and FS reports, No Further Action
32 documents, and RODs.

SECTION 1

1 Plan generally calls for at least 10 percent confirmatory split samples from each
2 media type per site to be submitted for laboratory analyses. Selection of the
3 confirmatory samples will, to the extent practicable, be based on field screening
4 results and should include samples exhibiting site-related contamination. Some field
5 screening samples exhibiting non-detect will be submitted as well. With the
6 exception of VOC analyses, soil samples will be homogenized prior to split-sample
7 collection. Soil samples submitted for field and analytical laboratory volatile organic
8 compound (VOC) analyses will not be homogenized. This may result in substantially
9 different field screening and laboratory analytical results for VOCs in soil. The
10 selection of specific samples for laboratory analysis will be conducted on a daily basis
11 upon reviewing the field screening results and geologic conditions encountered. The
12 criteria typically used to select samples for laboratory analysis include:

- 13 • Samples exhibiting visual or olfactory evidence of contamination;
- 14 • Elevated PID or field screening results;
- 15 • Samples collected at the top/bottom of contamination;
- 16 • Samples collected at geologic boundaries;
- 17 • Samples having anomalous field screening results; and
- 18 • Samples collected in clean zones, or those having no detects

1.1 TASK OBJECTIVES

27 The primary objective of this task is to prepare project plans for conducting RI/FS
28 activities for 13 Sites at Ft. Dix, New Jersey. These 13 Sites have previously been
29 investigated and have been assigned designations Site 2 through Site 6 and Site 8
30 through Site 15. Site 1 (the MAG-1 Area) and Site 7 (the NPL Landfill) are being
31 investigated under separate work efforts. The 13 Sites included in this work effort,
32 along with their historical site numbers and site identification (ID) abbreviations, are
33 as follows:

- 34 • Petroleum, Oil, Lubricants (POL) Area (Site 2, PL)
- 35 • Fire Training Tanks Area (Site 3, FT)

- 1 • Golf Course Leaking Tank Area (Site 4, GT)
- 2 • Transportation Motor Pool (Site 5, TP)
- 3 • Armament Research Development Center (ARDC) Test Site (Site 6,
- 4 AR)
- 5 • Pesticide Control Shop (Site 8, PC)
- 6 • New Egypt Armory (Site 9, NE)
- 7 • Range Landfill (Site 10, RL)
- 8 • ANC-9 Landfill (Site 11, A9)
- 9 • ANC-2 Disposal Area (Site 12, A2)
- 10 • Boiler Blowdown Area (Site 13, BB)
- 11 • Area North of Dogwood Lake (Site 14, DL)
- 12 • Golf Course Pesticide Mixing and Storage Area (Site 15, GP)

24 Figure 2 shows the locations of the 13 Sites at Ft. Dix. The two character,
25 alphanumeric Site ID abbreviations are explained in Section 17.0 of this Technical
26 Plan.

27 29 **1.2 SCOPE OF WORK**

31 Field activities under this task to meet the objectives described above are
32 summarized on a site-by-site basis in Table 1. The following is a summary of
33 investigative activities:

- 35 • Geophysical Investigation. Geophysical surveys using ground
36 penetrating radar (GPR) and magnetometer and terrain conductivity
37 (TC) will be conducted at selected sites to establish the boundaries of
38 disposal areas, and the need for and location of soil borings, test pits,
39 and monitoring wells.

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1 • Soils Investigation. Surface and subsurface soil samples will be
2 collected to evaluate contamination of soils at select sites. Field
3 screening of soils will be performed at select sites using field gas
4 chromatography (GC), infrared spectroscopy (IR), atomic absorption
5 (AA) and immunoassay test kits to evaluate potential contaminant
6 distribution. A gamma ray scintillating detector and GM pancake
7 probe will also be used for assessment of radiological parameters at
8 select sites.

9
10 • Hydrogeologic Investigation. Field screening using screened hollow-
11 stem augers (HSAs) or a Geoprobe system will be employed at select
12 sites to evaluate the need for additional monitoring wells. Analysis of
13 groundwater samples collected during field screening will be performed
14 with a field GC, IR, AA, and immunoassay test kits.

15
16 Groundwater samples for chemical analysis will be collected from
17 newly installed and existing wells. Groundwater elevation
18 measurements will be taken at new and existing monitoring wells to
19 establish groundwater flow directions. Slug testing will be conducted
20 at all newly installed wells to develop estimates of hydraulic
21 conductivity. Aquifer testing will be performed at the Golf Course
22 Leaking Tank Area to provide information for selection of potential
23 remedial alternatives at the site. Production well pumping will be
24 performed at the ARDC site (production well FTDIX-13) to assess
25 hydraulic communication.

26
27 • Surface Water and Sediment Investigation. Surface water and
28 sediment samples will be collected to evaluate impacts to drainage
29 ditches and water courses near selected sites, as appropriate. In
30 addition, staff gauges will be installed at select sites and measurements
31 taken at these locations during groundwater level measurements.

32
33 All project activities will be performed in accordance with USAEC QA/QC,
34 geotechnical, and data management protocols, as well as State of New Jersey and
35 USEPA Region II requirements.

1.3 TECHNICAL PLAN ORGANIZATION

This Technical Plan has been organized into major sections as follows:

- Section 1.0 Introduction
- Section 2.0 Site Background
- Section 3.0 POL Area - Site 2 (PL)
- Section 4.0 Fire Training Tanks Area - Site 3 (FT)
- Section 5.0 Golf Course Leaking Tank Area - Site 4 (GT)
- Section 6.0 Transportation Motor Pool - Site 5 (TP)
- Section 7.0 ARDC Test Site - Site 6 (AR)
- Section 8.0 Pesticide Control Shop - Site 8 (PC)
- Section 9.0 New Egypt Armory - Site 9 (NE)
- Section 10.0 Range Landfill - Site 10 (RL)
- Section 11.0 ANC-9 Landfill - Site 11 (A9)
- Section 12.0 ANC-2 Disposal Area - Site 12 (A2)
- Section 13.0 Boiler Blowdown Area - Site 13 (BB)
- Section 14.0 Area North of Dogwood Lake - Site 14 (DL)
- Section 15.0 Golf Course Pesticide Mixing and Storage Area - Site 15 (GP)
- Section 16.0 Technical Approach for Field Investigation
- Section 17.0 Analytical Program

SECTION 1

- 1 • Section 18.0 Quality Assurance/Quality Control
- 2 • Section 19.0 Data Management
- 3 • Section 20.0 Risk Assessment
- 4 • Section 21.0 Preliminary Identification of Potential Applicable
- 5 or Relevant and Appropriate Requirements
- 6 • Section 22.0 Health and Safety
- 7 • Section 23.0 Remedial Investigation/Feasibility Study and
- 8 Reporting
- 9
- 10
- 11
- 12
- 13

14
15 Sections 3.0 through 15.0 present previous investigations and the proposed scope of
16 work for each of the 13 Sites, including rationale, and the location and number of
17 environmental sampling points. Section 16.0 presents the technical approach for the
18 field investigation at the 13 Sites. This section describes the details of the
19 investigative techniques and analyses of the proposed field program for the 13 Sites,
20 including geophysics, field screening, geotechnical investigations (soil sampling,
21 borings, monitoring wells, surface water/sediment sample collection, and aquifer
22 testing), surveying, and groundwater modeling.

23
24 Figures and tables are presented at the end of the text sections as indicated by the
25 report tabs and are numbered sequentially through the Technical Plan. Not all
26 locations of environmental samples collected during previous investigations are
27 indicated on the figures; only sample collection points entered in to the USAEC's
28 Installation Restoration Data Management Information System (IRDMIS) prior to
29 October 1993 are indicated on the figures. Locations of other sample collection
30 points can be found in the reports referenced in Sections 3.0 through 15.0, in the
31 subsections entitled "Previous Investigations."

1 **2.0 SITE BACKGROUND**

2

3

1 **2.1 SITE LOCATION AND HISTORY**

2

3 Ft. Dix is located in Burlington and Ocean Counties, New Jersey, approximately 20
4 miles southeast of Trenton (Figure 1).

5 Ft. Dix is a permanent Class 1 Army installation, occupying approximately 31,110
6 acres. It consists of a Cantonment Area, a Training Area, and a Range and Impact
7 Area. The Cantonment Area occupies approximately one-third of the installation
8 (Figure 3). A much smaller area southeast of the Cantonment Area is designated
9 the Training Area, while the installation's eastern two-thirds is designated the Range
10 and Impact Area. McGuire Air Force Base is situated between the Cantonment
11 Area and the Range and Impact Area.

12 Ft. Dix, initially called Camp Dix, was established on July 18, 1917, as a cantonment
13 area and training post for World War I troops. After the war, the camp served as
14 a demobilization center, and from 1922 to 1926 it was used as a training ground for
15 Army, Army Reserve, and National Guard units. The camp was inactive from 1926
16 to 1933, but from 1933 to 1939 it served as a reception, discharge, and replacement
17 center for the Civilian Conservation Corps. In 1939, the camp became a permanent
18 Army installation, and its name was changed to Ft. Dix. The installation again
19 served as a reception and training center during World War II, and after the war it
20 was used as a separation center. In 1947, Ft. Dix was designated as a basic training
21 center and is currently used for that purpose. In 1956, the post was officially
22 designated the U.S. Army Training Center and Ft. Dix.

23 Prior to October 1992, Ft. Dix was a government-owned installation under the
24 jurisdiction of the U.S. Army Training and Doctrine Command (TRADOC). Its
25 mission was to conduct Basic Combat Training and Advanced Individual Training,
26 and to provide Combat Support and support to Reserve and National Guard Units.
27 In October 1992, the major command was shifted to Forces Command (FORSCOM).

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2.2 PHYSICAL SETTING

2.2.1 Site Physiography and Topography

Ft. Dix is located in the northern portion of the Atlantic Coastal Plain Physiographic Province, which is characterized by flat-to-gently rolling topography. Elevations range from about 70 feet to slightly over 200 feet above mean sea level (MSL). The Training Area and the western 75 percent of the Range and Impact Area are flat, with elevations varying between 80 and 100 feet MSL. Taylor's Mountain, located in the northwestern corner of the Range and Impact Area, is an exception to the generally flat topography of this section of the installation, rising about 50 feet above the surrounding terrain. The flat central portion of the installation is bounded on the east by a strip of higher ground measuring between one and two miles wide. Average elevation of this area is approximately 170 feet MSL with a local peak of 208 feet MSL. In the west, elevations rise steadily to between 170 and 180 feet then fall back to 70 feet MSL along the western boundary.

2.2.2 Climatology

The Ft. Dix area is characterized by moderate temperatures, precipitation, and wind velocities. The average annual temperature in the area is 54 degrees Fahrenheit ($^{\circ}\text{F}$), based on 43 years of data recorded at the nearby McGuire Air Force Base weather station. January is the coldest month (average temperature of 31°F) while July is the hottest month (average temperature of 76°F). According to the Air Force Weather Station Climatic Brief of January 1989, the coldest temperature recorded at the climate station was -8°F and the highest 102°F .

The average annual precipitation in the area is 44 inches. Precipitation is fairly well distributed throughout the year, with the average monthly precipitation ranging from 2.9 inches in February to 4.7 inches in August.

The prevailing wind direction is from the south during the summer months and from the west and northwest during winter. Wind speeds in the area average approximately 7 miles per hour (mph), but instantaneous speeds of up to 87 mph have been recorded.

1 **2.2.3 Soils**

2
3 At least six major soil associations are present at Ft. Dix. The three associations
4 covering most of the areas of concern are the Freehold-Holmdel-Adelphi association,
5 the Downer-Sassafras Woodstown association, and the Lakehurst Lakewood-
6 Eversboro association. The first two associations consist of soils that are well-to-
7 moderately well drained and have moderate-to-moderately slow permeabilities. The
8 third association is somewhat poorly-to-excessively drained with permeabilities
9 ranging from rapid to moderately rapid. Subsoils range from sandy clayey loam to
10 sand.

11 **2.2.4 Geology**

12
13 Ft. Dix is located in the Atlantic Coastal Plain Physiographic Province, approximately
14 15 miles east of the Fall Line separating the Piedmont and Coastal Plain
15 Physiographic Provinces. The wedge-shaped mass of sedimentary strata comprising
16 the Coastal Plain rests unconformably on the eastward continuation of the crystalline
17 rocks of the Piedmont Physiographic Province. Sedimentary strata and the surface
18 with the crystalline basement dip to the southeast. The approximate depth to the
19 crystalline basement in the Ft. Dix area is 1,000 feet. Figure 4 is the site geologic
20 map. Generalized subsurface stratigraphy including hydrogeologic units is shown in
21 Figure 5. The near-surface geologic setting as presented in the 1989 U.S. Army
22 Toxic and Hazardous Materials Agency (USATHAMA) Preliminary Assessment/Site
23 Investigation (PA/SI), are described below.

24
25 **Quaternary Deposits.** The Quaternary Period began about a million years ago with
26 the advance of the Pleistocene glaciers toward Burlington County. The last glacial
27 front began to retreat less than 20,000 years ago, marking the close of the Pleistocene
28 Epoch. Glaciers did not cover the Ft. Dix area, but they played a part in its
29 geological history. Sand, gravel, and clay materials were supplied by the glacial -
30 meltwaters and deposited in the stream valleys during the Quaternary Period.
31 Deposits of Quaternary age overlie much of the older formations. These deposits
32 include remnants of fluvial sand and gravel capping the higher hilltops and low,
33 broad alluvial plains on which Holocene stream channel and floodplain deposits
34 developed. Available information indicates that the western portion of the post,
35 including a major portion of the Cantonment Area, has a thin Quaternary deposit
36 from early and interglacial times. This unit, termed the Bridgeton Formation, is
37 composed of gravel and sand, in part solidified by iron oxide, capping higher hills and
38 divides. The thickness of the Bridgeton Formation is reported to range from 0 to
39

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1 40 feet and is usually hydraulically connected to underlying Beacon Hill and
2 Cohansey Formations (Rush, 1968).

3
4 **2.2.4.1 Cohansey Formation.** The Cohansey Formation of Pliocene/Miocene age
5 underlies Quaternary deposits or crops out in all of the southeastern half of
6 Burlington County, including portions of the Ft. Dix Cantonment and Range and
7 Training areas. The outcrop/subcrop area in Burlington County is approximately 46
8 percent of the total county area. The Cohansey Formation is described by Minard
9 and Owens (1962) from an outcrop in the Columbus Quadrangle (United States
10 Geologic Survey [USGS] 7.5-minute series-topographic map) as being a light gray to
11 yellowish brown, medium-coarse grained, ilmenitic, pebbly, quartz sand with local
12 pink and white kaolinitic beds in the upper part of the formation. Ironstone is locally
13 present, such as at Taylor's Mountain and Arneys Mount. A characteristic feature
14 of the formation in outcrop is its common horizontal and cross-stratification.

15
16 The lithology of the formation is variable, ranging from clayey quartz silt to gravelly
17 quartz sand. The thickness of the Cohansey Formation ranges from approximately
18 50 feet in the Ft. Dix area to 250 feet southeast and downdip of the Ft. Dix outcrop
19 area. The average strike of this unit is N80E with a dip of 8 to 12 feet per mile
20 (ft/mi) to the southeast. The lower two-thirds of the formation is composed of thick
21 gravelly quartz sand beds and thinner silt beds. The upper third is mostly sandy silt.
22 The Cohansey Formation unconformably overlies the Kirkwood Formation.
23 Glauconite, which is indicative of a deeper marine depositional environment, is not
24 present in the Cohansey Formation and it is generally assumed that the Cohansey
25 Formation represents beach and near-shore marine deposits. The environment of
26 deposition for the Cohansey Formation, however, is subject to various interpretations.
27 Markewicz et al. (1958) interpret the Cohansey Formation as being a large alluvial
28 fan deposit. This is supported by its common coarse texture, poor sorting and
29 cross-bedding. Owens and Minard (1960) favor a beach depositional environment
30 and discount the alluvial fan environment because of the widespread nature of the
31 deposit.

32
33 **2.2.4.2 Kirkwood Formation.** The Kirkwood Formation was deposited during the
34 Miocene Epoch of the Tertiary Period. This formation crops out in a thin belt along
35 the western boundary of Ft. Dix and a larger, irregular shaped area in the Range and
36 Training areas. The Kirkwood Formation underlies the Cohansey Formation in the
37 Ft. Dix area. Minard and Owens (1962) described the Kirkwood Formation from an
38 outcrop in the Columbus Quadrangle where they divided the formation into two
39 units: a basal unit of brownish-black clayey silt to very fine-grained quartz sand, and

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1 a thicker upper unit of very light-gray to light yellow orange, very fine to fine grained,
2 well-sorted quartz sand. Muscovite, ilmenite, and lignite are important, minor
3 constituents of both units. Small amounts of glauconite have been found in the basal
4 unit.

5
6 The Kirkwood Formation thickens downdip to form a wedge-shaped unit. The
7 formation has an average strike of N75E and dips to the southeast at a rate of
8 11-25 feet per mile (ft/mi.). The thickness of the formation in the outcrop in the
9 Columbus Quadrangle, as reported by Minard and Owens (1962), is as much as
10 50 feet, with the basal unit measuring as much as 15 feet. From boring logs in test
11 wells drilled downdip, the Kirkwood Formation thickens to 250 feet southeast of the
12 Ft. Dix area.

13
14 The Kirkwood Formation unconformably overlaps the Hornerstown, the Vincentown,
15 and Manasquan Formations in Burlington County, and is unconformably overlain by
16 the Cohansey Formation. Fossils and glauconite found in the Kirkwood Formation
17 indicate it to be of marine origin.

18
19 **2.2.4.3 Manasquan Formation.** The Manasquan Formation was deposited during
20 the Eocene Epoch of the Tertiary Period. This formation crops out in a thin belt
21 along the western boundary of Ft. Dix and at a small area near Brindle Lake. The
22 Manasquan Formation underlies the Kirkwood Formation and is described by Owens
23 and Minard (1960) as being a clayey, quartz-glauconite sand. The Manasquan
24 Formation thickens and dips to the southeast to form a wedge-shaped unit. The
25 formation thickness at Browns Mills, New Jersey, varies from 10 to 15 feet along the
26 southern Ft. Dix boundary and increases to a maximum of 270 feet downdip (Rush,
27 1968).

28
29 This formation is the least exposed unit in the Coastal Plain of New Jersey. The
30 Manasquan Formation strikes in a N 60E direction and dips to the southeast at a
31 rate of 15-31 ft/mi.

32
33 **2.2.4.4 Vincentown Formation.** The Vincentown Formation was deposited during
34 the Paleocene Epoch of the Tertiary Period. This formation crops out in a thin belt
35 between Juliustown and Lewistown in the southwest area of the Ft. Dix Military
36 Reservation. Throughout the region, the Vincentown crops out generally in a one
37 to two mile wide belt immediately southeast of the Hornerstown Formation outcrop
38 area. The Vincentown Formation has been divided into two members. The upper
39 member is a light brown to light gray calcarenite with abundant sand-size fragments

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1 of bryozoa, foraminifera, and corals. The lower member is a gray, glauconitic,
2 slightly clayey, poorly sorted, medium-grained quartz sand with a small amount of
3 mica.

4 This formation thickens downdip to form a wedge-shaped unit. Average strike is N
5 60E and the unit dips at a rate of 20-30 ft./mi. Thickness near Wrightstown (near
6 the outcrop area) is reported to be 30 feet, whereas downdip the thickness increases
7 to about 185 feet. The Manasquan Formation unconformably overlies the
8 Vincentown Formation and the Hornerstown Formation unconformably underlies the
9 Vincentown Formation. Fossils and glauconite found in the Vincentown Formation
10 indicate that it is of marine origin (Rush, 1968).

12 **2.2.4.5 Hornerstown Sand.** The Hornerstown Sand was deposited during the
13 Paleocene Epoch of the Tertiary Period. This formation outcrops in an irregularly
14 shaped belt northwest of the Vincentown Formation. The Hornerstown Sand is
15 characteristically a glauconitic sand with a dark green clay matrix. Fossils and the
16 very high glauconite content indicate the Hornerstown Sand is of marine origin.
17

18 The Hornerstown Sand is approximately 29 feet thick at Wrightstown near the
19 outcrop area and thickens downdip to the southeast. The Hornerstown Sand
20 unconformably overlies the Navesink Formation and Red Bank Sand Formations.
21 The Hornerstown Formation underlies the Vincentown Formation.
22

24 **2.2.4.6 Red Bank Sand.** The Red Bank Sand Formation was deposited during the
25 Cretaceous Period. This formation outcrops in an irregular area occupying one to
26 two square miles in Burlington County. The Red Bank Sand is characteristically
27 composed of two unnamed units. A lower unit is described as a thin glauconitic
28 sandy clay containing minor amounts of pyrite, lignite, and mica. An upper unit is
29 described as a thick quartz sand with small amounts of clay, glauconite, and mica.
30 A typical sample of the Red Bank Sand from the outcrop area near Arneytown had
31 73 percent sand and 27 percent silt and clay.
32

33 The Red Bank Sand is approximately 50 feet thick at Cookstown. The Red Bank
34 Sand conformably overlies the Navesink Formation and is unconformably overlain
35 by the Hornerstown Sand.
36

37 **2.2.4.7 Navesink Formation.** The Navesink Formation was deposited during the
38 Cretaceous Period. This formation outcrops in an irregularly shaped belt located
39 southeast of outcrops of the Mount Laurel Formation. The Navesink Formation is

1 typically described as a clayey glauconitic sand to a glauconitic, micaceous, sandy
2 clay. The clay and mica contents of this formation increase upward. Overall, the
3 formation is very micaceous and has a very prominent shell bed at its base.

4
5 The Navesink Formation is approximately 37 to 40 feet thick and does not thicken
6 appreciably downdip. The Navesink Formation conformably overlies the Mount
7 Laurel Formation and conformably underlies the Red Bank Sand.

8 **2.2.5 Hydrogeology**

9
10 There are five major aquifers in the Coastal Plain: the Potomac-Raritan Magothy
11 aquifer, Englishtown aquifer, Mt. Laurel-Wenonah aquifer, the lower "800-foot" sand
12 aquifer of the Kirkwood Formation, and the Kirkwood-Cohansey aquifer. These
13 aquifers are separated by relatively impermeable units that vary in thickness and in
14 their ability to function as confining layers. Hydrogeologic units of concern at the
15 installation are discussed below.

16
17 The wedge-shaped mass of sedimentary strata underlying Ft. Dix can be divided into
18 two separate aquifer systems. The upper flow regime is the most active and extends
19 to a depth of approximately 50 feet below the surface. The surficial aquifer in the
20 Ft. Dix area that comprises this upper flow regime includes the Cohansey and
21 Kirkwood Formations. The Cohansey Formation is a highly permeable sand deposit
22 with thin, discontinuous sections of laminated clay. The Kirkwood Formation
23 underlies the Cohansey Formation and can be divided into two units: a basal unit
24 of brownish-black, clayey-silt to very fine-grained quartz sand with mica, and a
25 thicker upper unit of very light gray to light clayey-silt to very fine-grained quartz
26 sand with mica, and a thicker upper unit of very light gray to light yellow orange,
27 very fine to fine-grained sand. Hydrologic continuity exists between the Cohansey
28 Formation and the upper strata of the Kirkwood Formation. The basal unit of the
29 Kirkwood and a group of formations including the Manasquan, Vincentown,
30 Hornerstown, Red Bank, and Navesink Formations function as a composite confining
31 layer and separate the upper Kirkwood-Cohansey Aquifer from the lower Wenonah-
32 Mount Laurel Aquifer. A small percentage of groundwater that infiltrates through
33 the upper flow system will enter the deeper flow system. Groundwater in the shallow
34 regime follows local flow lines from areas of infiltration to areas of discharge. This
35 discharge occurs where the water table intersects the surface of the ground, creating
36 a surface water body.
37

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1 The Cohansey Formation is an important aquifer in Burlington County because it is
2 essentially untapped. Most of the formation is under water table conditions. The
3 biggest drawback to use of water from this formation is that it is close to the surface,
4 thereby increasing the potential for surface contamination. Published well data for
5 the area indicates that the Cohansey Formation is not being used as a source of
6 drinking water. The Cohansey Formation discharges into the Rancocas Creek and
7 the Mullica, Wading, and Bass Rivers (Rush, 1968).

8 The Kirkwood Formation is of minor importance as a useful aquifer in Burlington
9 County. It is tapped only by low-yield domestic wells only in the formation outcrop
10 area. Ft. Dix production wells MW #9 through MW #12 are screened in the
11 Kirkwood Formation and the water is chlorinated prior to use. Groundwater
12 movement is toward lowland areas where water is discharged to Rancocas Creek and
13 the Mullica and Bass Rivers (Rush, 1968).

14 The composite confining unit, which is 150 to 200 feet thick in the Ft. Dix area
15 separates the Kirkwood-Cohansey Aquifer from the deeper aquifer system, consisting
16 of the Mt. Laurel-Wenonah aquifer, a major water supply aquifer. Because of water
17 supply pumping, the heads in the Mt. Laurel-Wenonah aquifer have been lowered
18 and a resultant significant downward gradient exists across the aquitard units
19 separating the Kirkwood-Cohansey aquifer from the Mt. Laurel-Wenonah aquifer.
20 The Mt. Laurel-Wenonah aquifer is described as fine-to-coarse-grained sand of late
21 Cretaceous age. The Mt. Laurel Formation overlies the Wenonah Formation and
22 consists of coarser sand and therefore is the principal component of this aquifer.

23 The Englishtown, Magothy, and Raritan Formations, and the Potomac Group contain
24 important aquifers below the Mt. Laurel-Wenonah aquifer. The Englishtown
25 Formation is tapped for minor water supplies and is characterized as a light gray to
26 white, micaceous, lignitic, fine-grained quartz sand. In 1968, only public water supply
27 wells tapped this aquifer. Two wells at Marlton, New Jersey, yield about 100 gallons
28 per minute (gpm) each with drawdowns of about 36 feet. Reported maximum
29 thickness of the Englishtown is 220 feet. The Magothy-Raritan-Potomac sequence
30 contains the most important and productive aquifers in Burlington County. Most
31 industries adjacent to the Delaware River and most public water supplies throughout
32 the county obtain groundwater from these deeper aquifers. Large diameter wells
33 tapping this sequence yield in excess of 1,500 gallons per minute (gpm). This
34 stratigraphic sequence consists chiefly of light gray to white, cross-stratified, medium-
35 to-coarse-grained quartz sand, interbedded with white to red and white variegated
36 clay. In the Wrightstown, New Jersey area, the deeper aquifers are developed

1 extensively for water supplies to serve Ft. Dix, McGuire Air Force Base, and
2 Wrightstown.

3
4 The Merchantville and Woodbury Formation form a major confining unit throughout
5 most of the Coastal Plain of New Jersey. These units are of early-middle Cretaceous
6 age and separate the Potomac-Raritan Magothy aquifer from that of the overlying
7 Englishtown Formation. The Merchantville-Woodbury confining unit consists of gray
8 and black, micaceous clay with some local areas of very fine-grained quartz and
9 glauconitic sand. The maximum reported thickness for this confining unit is 325 feet.
10 Recharge to the Raritan and Magothy Formations from the Englishtown Formation
11 takes place as a result of vertical leakage through these formations.

12
13 The Marshalltown Formation overlies the Englishtown Formation in most of the
14 Coastal Plain. This formation has a maximum reported thickness of 30 feet and
15 consists of gray and black, very clayey, very fine-to-medium-grained quartz and
16 glauconitic sand. Because of its limited thickness and some local, slightly to
17 moderately permeable beds, its ability to function as a confining unit is locally
18 reduced. The Marshalltown Formation separates the Englishtown aquifer from the
19 Mt. Laurel-Wenonah aquifer. The Mt. Laurel-Wenonah aquifer is overlain by a
20 dominantly confining sequence composed of several geologic units. This confining
21 sequence consists of the Navesink, Red Bank, Tinton, Hornerstown, Vincentown,
22 Manasquan, Shark River, and Piney Point Formations, and the basal clayey silt of the
23 Kirkwood Formation. The maximum reported thickness is approximately 900 feet.
24 These units consist of sandy material with varying amounts of clay. Some of these
25 geologic units may contain water-bearing zones on a localized basis.

27 2.2.6 Surface Water Hydrology

28
29 The Ft. Dix installation is drained by several perennial and intermittent tributaries
30 of Crosswicks Creek and the North Branch of Rancocas Creek. For Crosswicks
31 Creek, these tributaries include Jumping Brook and North Run; for the North Branch
32 of the Rancocas, tributaries include the Ong and Newbold Runs. The North Branch
33 of Rancocas Creek is located immediately south of Ft. Dix and flows westward into
34 the Delaware River. Crosswicks Creek is also a tributary to the Delaware River, but
35 first flows northward from the northern boundary of Ft. Dix for a distance of about
36 6 miles before turning west toward the Delaware River. The total length of stream
37 channels within the installation has been estimated to be 54 miles. Several streams
38 are bordered by swamps along significant segments of their lengths, indicating
39 relatively shallow depths to groundwater.

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1 The Ft. Dix area is also characterized by several ponds and lakes ranging from
2 General's Pond, which measures about 1 acre in surface area, to Brindle Lake, which
3 has a surface area of about 40 acres. Figure 2 shows water resource features,
4 including the major streams, ponds, and lakes within and around Ft. Dix.
5
6

2.3 ENVIRONMENTAL STUDIES AT FT. DIX

7 Numerous environmental studies have been published on various aspects of Ft. Dix.
8 Eight of the more significant studies are discussed below in chronological order.
9
10

11 An Installation Assessment of Ft. Dix (Boeing Michigan Army Research Center
12 [BOMARC] Site) was completed by USATHAMA in 1977. This document describes
13 the results of a records search conducted on Ft. Dix to estimate possible
14 contamination at the installation by chemical, biological, and radiological material
15 and to assess the possibility of contaminant migration beyond the installation
16 boundary. As a result of the assessment, USATHAMA concluded that a more
17 definitive survey of the BOMARC site was necessary and that the records did not
18 indicate that contaminants were migrating beyond Ft. Dix boundaries from the
19 remainder of the installation (USATHAMA, 1977).
20
21

22 Two reports on pesticide distribution and monitoring at Ft. Dix were compiled by the
23 U.S. Army Environmental Hygiene Agency (USAEEHA) in 1975 and 1985. These
24 reports examined the distribution of pesticide residues at various sites at Ft. Dix.
25 The 1975 pesticide report identified several locations that exceeded the action level
26 recommended by the National Pesticide Monitoring Program. The 1985 study further
27 defined pesticide contamination at six sites at Ft. Dix (USAEEHA, 1975, 1985).
28
29

30 A report was prepared by Iffland, Kavanaugh, Waterbury, P.C. (IKW) detailing the
31 results and findings of groundwater testing at three locations at Ft. Dix. The three
32 sites were the Golf Course Area, Transportation Motor Pool, and an area north of
33 Dogwood Lake. The report presented the results of the sampling program and
34 recommended remedial measures (IKW, 1986).
35
36

37 An Environmental Noise Assessment of Ft. Dix was completed in 1986 by USAEEHA.
38 This Installation Compatible Use Zones (ICUZ) Report suggests types and intensities
 of land uses that take into consideration noise exposure in the Ft. Dix area. The
 report did not consider the impact of noise from adjacent land uses, such as McGuire

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1 Air Force Base, on Ft. Dix. The report indicates wide range of compatible land uses
2 surrounding Ft. Dix; however, there were some incompatibilities (USAEHA, 1986).

3
4 EA Engineering, Science, and Technology, Inc. (EA), under contract to
5 USATHAMA, prepared a PA/SI of environmental conditions at Ft. Dix. The report
6 presents the results from soil and groundwater investigations at 16 sites and TC
7 terrain conductivity surveys at four other sites. Recommendations were presented
8 for additional investigative studies at nine sites (EA, 1989).

9
10 Dames and Moore, under contract to USATHAMA, performed a RI at Ft. Dix. The
11 RI Phase I was conducted at 15 sites and the RI Phase II was conducted at nine sites.
12 The purpose of the RI was to investigate the nature and extent of water, soil, and
13 sediment contamination caused by past operations at the studied sites, to evaluate
14 the potential for contaminant migration, and to assess risks to public health and the
15 environment posed by contamination at the studied sites (Dames and Moore, 1991,
16 1992). The Final RI Report was published in 1993 (Dames and Moore, 1993).

17
18 R.F. Weston, Inc., under contract to USATHAMA, prepared an Enhanced PA in
19 December 1991 that identified 42 areas at Ft. Dix requiring environmental
20 evaluation. A review of readily available site environmental literature was conducted
21 to evaluate releases of hazardous or potentially hazardous substances to the
22 environment. Recommendations for additional work and conclusions on the 42 areas
23 were presented (Weston, 1991).

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3.0 POL AREA (SITE 2)

1 The POL Area is located near the intersection of Rancocas Road and Lexington
2 Avenue in the northwest part of the Cantonment Area (Figure 3). The POL Area
3 has served as a warehouse and central supply facility for approximately 40 years. In
4 1988, the Ft. Dix Environmental Office removed five underground storage tanks
5 (USTs) from the site; two of the removed USTs were reportedly leaking. This effort
6 reportedly included removal of contaminated soils and soil sampling. The leaking
7 USTs contained diesel fuel and Type II dry cleaning solvent. Type II dry cleaning
8 solvent is 100 percent aliphatic naphtha. Aliphatic naphtha, like diesel fuel, has a
9 density less than water and is therefore considered a light non-aqueous phase liquid
10 (LNAPL).

11

12

13 **3.1 PREVIOUS INVESTIGATIONS**

14

15 Two previous investigations have been completed for USAEC at the POL Area and
16 include a PA/SI (EA, 1989) and a Phase I and II RI (Dames and Moore, 1993).

17

18 As part of the PA/SI, four water table monitoring wells were installed (POL-5
19 through POL-8) and a groundwater sample was collected from each well in 1986 and
20 analyzed for VOCs and semivolatile organic compounds (SVOCs) (Figure 6).
21 Analytical results detected naphthalene (8 micrograms per liter [$\mu\text{g}/\text{L}$]) and fluorene
22 ($2 \mu\text{g}/\text{L}$). The PA/SI indicated the likely source of these contaminants to be the
23 leaking diesel fuel tank and dry cleaning solvent tanks. Dames and Moore, under
24 contract to USATHAMA, conducted an RI at the POL Area (1993). Investigations
25 included the installation of three additional groundwater monitoring wells (POL-48
26 through POL-50) (1988), sampling and analysis of new and existing wells for VOCs
27 and SVOCs (1988), and water level elevation measurements in 1990 and 1991.

28

29 Groundwater at the POL has been interpreted to flow to the southwest. Surface
30 water runoff from the site also flows southwesterly into an unnamed intermittent
31 stream that eventually discharges into Dogwood Lake. VOCs (benzene,
32 ethylbenzene, and xylene) and SVOCs (2-methylnaphthalene and acenaphthene) were
33 detected in groundwater in 1988 at well POL-6. The Ft. Dix Environmental Division
34 reported TPH concentrations in soil associated with the tank removal that ranged
35 from below detection to 6,700 milligrams per kilogram (mg/kg).

36

SECTION 3

1 Results of previous investigations at the POL Area indicate that groundwater
2 contamination exists in the vicinity of POL-6, which appears to be located down-
3 gradient of the oil transfer point for the 420,000-gallon aboveground No. 2 fuel oil
4 storage tank. Detected groundwater contamination as well as the historical storage
5 of fuels at this site suggest that groundwater contamination consists of VOCs and
6 SVOCs with densities less than water. As such, if there are substantial contaminant
7 plumes underlying the locations of the former USTs, they may occur as either
8 LNAPLs or as dissolved contaminants. LNAPLs have not been detected at this site
9 to date while dissolved contaminants have. The scope of work outlined below is
10 intended to further characterize the nature and distribution of subsurface soil and
11 groundwater contamination at this site.

3.2 PROPOSED SCOPE OF WORK

16 The objectives of this RI for the POL site are to:

- 18 1. establish the locations of the removed USTs,
- 19 2. establish whether surface runoff from the POL Area has affected
- 20 21 downgradient surface water/sediment quality,
- 22 3. establish whether a source of contamination exists in the area of the
- 23 24 removed USTs,
- 25 4. assess the nature and distribution of contaminants associated with the
- 26 27 former USTs,
- 28 5. establish whether contaminants are migrating from the site through
- 29 30 groundwater,
- 31 6. assess the potential risks to human health and the environment
- 32 33 associated with site-related contamination, and
- 34 7. provide adequate data for assessment of remedial alternatives.

37 Table 1 summarizes the proposed scope of work and planned investigations for the
38 POL Area.

1 **3.2.1 Site Topographic Base Map**

2
3 To better evaluate existing conditions at the POL and facilitate any remediation of
4 this site, an accurate base map will be prepared. The map should be prepared
5 before conducting fieldwork at this site and will accurately portray all existing
6 structures including roads, fences, buildings, utilities, manholes, storm sewers,
7 drainage ditches, water courses, monitoring wells, fuel storage structures, tree lines,
8 and so forth. In addition, the base map shall include ground surface topography with
9 two-foot contour intervals (this may require new photogrammetry to be performed).
10 The map shall extend from the POL Area to include the Golf Course Leaking Tank
11 Area (see Subsection 5.2.1 of this Technical Plan. The map shall be presented in
12 hardcopy and computer aided design (CAD) compatible computer disk file(s). The
13 map shall use the Universal Transverse Mercator (UTM) system for horizontal grid
14 markings with a 1-inch = 100-foot scale. The topographic contours shall be based
15 on the National Geodetic Vertical Datum (NGVD) of 1929. This activity should be
16 coordinated with the field checking of existing monitoring wells (see
17 Subsection 3.2.4.1 of this Technical Plan).

18
19 **3.2.2 Geophysics**

20
21 To focus the field program at this site, approximate locations of the former USTs will
22 be estimated using GPR techniques. See Subsection 16.1.1 of this Technical Plan
23 and Subsection 2.4.2 of the QAPP for a detailed discussion of the GPR program.
24 The area to be surveyed with GPR is shown in Figure 6. The GPR survey will be
25 based on grid transects spaced at approximate 10 foot intervals over an area of
26 approximately one half acre. The approximate limits of the UST excavation will be
27 mapped and delineated in the field using wooden stakes. This information will be
28 used to refine the location of the field screening and monitoring well installations.

29
30 **3.2.3 Field Screening**

31
32 Field screening at the POL will include soil sampling to assess any residual soil
33 contamination at the location of the five former USTs, and groundwater sampling to
34 assess groundwater quality impacts. Careful coordination with Ft. Dix personnel will
35 be needed to locate the field screening explorations in areas where buried utilities
36 are not present.

37
38 **3.2.3.1 Soil Field Screening.** Up to five soil borings (PLB-01 through PLB-05) will
39 be located in the immediate vicinity of the five former USTs. Results of the GPR

SECTION 3

1 survey will be used locate the soil borings. The borings will be advanced with 4.25-
2 inch HSAs to the water table (estimated depth 15 feet bgs). If LNAPL is
3 encountered, the borings will be advanced to the bottom of the LNAPL.

4 Continuous soil samples will be collected in these borings and submitted for field
5 screening of benzene, toluene, ethylbenzene, and xylene (BTEX) by gas
6 chromatography (GC) and TPH by IR (see Table 3). Soil samples collected at or
7 just above the water table, as well as just above confining layers, will also be
8 submitted for ultraviolet (UV) screening. At least 10 percent of the samples will be
9 submitted for confirmatory laboratory analysis of TCL VOCs, TCL SVOCs, TAL
10 metals, total organic carbon (TOC), and TPH.
11

12 **3.2.3.2 Groundwater Field Screening.** A geoprobe/screened auger field screening
13 program will be completed to establish the absence or presence of potential
14 groundwater contamination extending from the POL. Site conditions will dictate
15 which technique is most suitable for this site. Up to five borings (PLA-01 through
16 PLA-05) will be completed to characterize the lateral and vertical extent of a
17 potential groundwater plume. Results of the GPR survey will be used to locate the
18 borings. It is anticipated that one boring will be located in the suspect source area.
19 The remaining four borings will be positioned downgradient of the source area.
20 Figure 6 highlights the general location of the downgradient borings. Water samples
21 will be collected from the screened auger borings at 5-foot intervals beginning at the
22 water table (estimated depth 15 feet bgs). Sampling will extend to approximately 35
23 feet bgs although this depth may be reduced if the first two borings indicate
24 groundwater contamination is shallower.
25

26 Field screening samples will be analyzed for BTEX and TPH by GC and IR,
27 respectively. These analyses are appropriate for the types of materials stored at this
28 site and lend themselves well to field screening technologies. Approximately
29 10 percent of the field screened samples will be sent off-site for confirmatory
30 laboratory analysis for TCL VOCs, TCL SVOCs, TAL metals (nonfiltered and
31 filtered), total suspended solid (TSS) and TPH. Results from the field screening
32 effort will be reviewed with the USEPA and NJDEP to determine the need to install
33 additional monitoring wells.
34

3.2.4 Geotechnical Investigations

35 The following subsections describe additional geotechnical investigations and surface
36 water/sediment sampling that will be completed at the POL.
37

1 **3.2.4.1 Monitoring Well Groundwater Sampling.** Prior to installing new monitoring
2 wells at the POL Area, an existing well survey will be performed to confirm their site
3 identification, location, and physical integrity. Existing monitoring wells will be
4 checked for their label/Site ID and location as compared to that indicated on
5 Figure 6. Monitoring wells will also be sounded for water depths and well bottoms.
6 Sounding depths shall be compared to those presented in Table 2. Monitoring wells
7 that are mislabeled and cannot be accurately located from the field checking shall
8 be resurveyed by a New Jersey-licensed land surveyor. Subsection 16.6 addresses the
9 criteria to be used in determining if monitoring well surveying is needed.

10 If the field screening program indicates that the former USTs have impacted
11 groundwater at the POL and existing wells are not adequately positioned to detect
12 and monitor this impact then up to five additional monitoring wells will be installed
13 at the POL (PLG-01 through PLG-05). The additional wells would be positioned at
14 and downgradient of the identified source area to characterize and assess
15 groundwater quality impacts. It is anticipated that the monitoring wells will be
16 screened across the water table to detect free floating and dissolved contaminants.
17 However, the position of the wells will be based on the results of the field screening
18 program. A soil sample from the well screen interval of each new monitoring well
19 will be submitted for analysis of grain size distribution.

20 One round of groundwater samples will be collected from new and existing
21 monitoring wells. The samples will be analyzed for TCL VOCs, TCL SVOCs and
22 TAL metals (nonfiltered and filtered) and TSS (Table 1).

23 Concurrent with groundwater sampling, a complete round of groundwater level
24 measurements will be taken from existing and new monitoring wells. In addition,
25 in-situ hydraulic conductivity testing will be performed at the new monitoring wells.
26 Data collected from these tests, when combined with the flow gradients and
27 directions calculated from measured water levels, can be used to estimate
28 groundwater flow velocities in the vicinity of the wells.

29 **3.2.4.2 Surface Water/Sediment Samples.** Existing storm sewer plans and discharge
30 locations at the POL will be reviewed and verified with field observations. Up to
31 five surface water and sediment samples (PLD/PLW-01 through PLD/PLW-05) will
32 be collected at the observed POL storm sewer discharge locations and downgradient
33 drainages (Figure 6). Final locations of the five samples will be selected after a
34 complete review of storm sewers that potentially drain the POL Area. Currently, it

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1 is anticipated that one sample will be collected upstream of the POL Area and four
2 samples will be collected at or downstream of the POL Area.

3 These samples will be submitted for laboratory analysis of TCL VOCs, TCL SVOCs,
4 TAL metals, TOC (sediment samples only), alkalinity/hardness (surface water only),
5 polychlorinated biphenyls (PCBs), and grain-size analyses (sediment only) (Table 4).
6 To the extent practicable, these samples will be collected when surface water is
7 present in the drainage ditches and or during a surface water runoff event. The
8 laboratory analyses of these samples will assess whether the storm sewer flow or
9 runoff from the POL are adversely impacting surface water and sediment quality in
10 the downgradient drainage ditches and streams.
11

4.0 FIRE TRAINING TANK AREA (SITE 3)

The Fire Training Tank Area (FTTA) is situated in the northwestern part of the Cantonment Area, south of the Firehouse. The FTTA site contains two 30-foot diameter soil berms (Figure 7). One berm contains an open steel circular tank (approximately 15 to 20 feet in diameter and two feet high). This tank reportedly was used for fire training from the 1960s to the 1980s. The second berm contains a geotextile reinforced pit (approximately 15 to 20 feet in diameter and two feet high). This pit was reportedly never used for fire training as the geotextile fabric was too slippery to train on.

4.1 PREVIOUS INVESTIGATIONS

Several previous investigations have been conducted at the FTTA. These investigations are discussed below in chronological order.

EA, under contract to USATHAMA, prepared a PA/SI of environmental conditions at Ft. Dix, including the FTTA (EA, 1989). The PA/SI indicates that two groundwater monitoring wells were installed (FTT-13 and FTT-14). Two groundwater sampling events, October 1986 and April 1987, were performed on FTT-13 and FTT-14. Monitoring well PTS-19, located at the Paint Shop was used as a background well. The samples were analyzed for VOCs and SVOCs in 1986 and VOCs in 1987. The analytical results from these wells reveal concentrations of 1,1,1-trichloroethane (111TCE) at 9 and 13 µg/L for FTT-13 and FTT-14 respectively for 1986 and below detection limits for SVOCs for both wells. Both FTT-13 and FTT-14 were below detection limits for VOCs in 1987. Monitoring well PTS-19 was below detection limits for VOCs and SVOCs in 1986 and VOCs in 1987.

Dames and Moore, under contract to USATHAMA, conducted an RI at the FTTA (Dames and Moore, 1993). Investigations conducted as part of the RI included the collection and analysis of eight soil samples from four soil borings (SC-124 through SC-127); installation of one groundwater monitoring well (FTT-51), collection and analysis of groundwater samples from monitoring wells FTT-13, FTT-14, and FTT-51; collection and analysis of two surface soil samples (SC-126 and SC-127); and collection and analysis of two surface water and four sediment samples (SW/SE-103, SW/SE-104, SE-111, and SE-112). Results of the soil boring samples indicate VOC, SVOC, and TPH contamination. The groundwater sampling results indicate that

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1 VOCs were not detected and the surface soil samples indicate SVOC contamination.
2 Results of the surface water and sediment samples indicate VOC contamination up
3 to 37 parts per billion (ppb).

4
5 The U.S. Army Corps of Engineers, Waterways Experiment Station (USACOE-WES)
6 was tasked by the USAEC to perform a Site Characterization and Analysis
7 Penetrometer System (SCAPS) site investigation at a series of sites at Ft. Dix,
8 including the FTTA. This work, published in 1993 (USACOE-WES, 1993), was
9 designed to develop screening level data regarding subsurface contamination of
10 petroleum, oil and lubricants. The SCAPS investigation did not detect significant
11 trends that would suggest a substantial contaminant source attributable to the fire-
12 training tanks at the FTTA.

13
14
4.2 PROPOSED SCOPE OF WORK

15 Results of previous investigations at the FTTA indicate soil and surface water and
16 sediment contamination by VOCs, mainly chlorinated solvents and SVOCs.
17 Groundwater VOC concentrations have been below detection limits since the first
18 sampling event in 1986.

19 The objectives of the RI for this site are to:

20
21
22
23
24 1. further define the distribution of soil, groundwater, surface water, and
25 sediment contamination, and
26
27 2. assess the potential risk to human health and the environment
28 associated with contaminants.

29
30 The proposed scope of work is to be implemented in a phased approach. If the first
31 phase field screening results indicate the FTTA is not the source area for
32 contamination previously detected in this vicinity, the second phase will not be
33 conducted. The first phase will include a monitoring well survey, collection of
34 surface water and sediment samples, and the collection of subsurface soils for field
35 screening to determine the presence of contamination. The implementation of the
36 second phase investigation is contingent on contamination being detected during the
37 first phase field screening of subsurface soils. A brief technical memorandum will
38 be prepared at the conclusion of the first phase to outline the extent of the second
39 phase.

1 The second phase investigation will consist of additional soil borings, and the
2 installation of shallow and deep monitoring well clusters to establish the distribution
3 of contamination. Two piezometers will also be installed to assess hydraulic
4 communication between Dogwood Brook and the water table aquifer.

5

6 **4.2.1 Field Screening**

7

8 The first phase subsurface soil field screening program consists of the installation of
9 two soil borings (FTB-01 and FTB-02); one boring will be located in the open steel
10 tank and the other soil boring will be located in the bermed pit (Figure 7). The
11 objective of the program is to establish if contamination exists at the source area.
12 If no contamination is detected, the second phase investigation will not be
13 implemented.

14

15 Prior to advancing the soil borings, the steel tank and bermed pit will be checked for
16 a solid bottom by using a hand auger or shovel to excavate a two to three foot deep
17 hole inside the tank/pit. If a solid bottom is encountered, the boring shall be
18 relocated just outside the tank/pit. After this preliminary investigation, the soil
19 borings will be drilled to the top of the first confining geologic unit, estimated to be
20 45 feet bgs, and samples will be collected continuously. For the purposes of this
21 Technical Plan, it is assumed that a confining layer will be defined as five or more
22 feet of fine-grained cohesive soils with a United Soil Classification System (USCS)
23 classification of CH, CL, ML, and possibly SC. This definition may be revised based
24 upon the geologic conditions encountered. Each soil sample will be field screened
25 for BTEX and chlorinated solvents (111TCE) utilizing a field GC. Soil samples
26 collected at or just above the water table, as well as just above confining layers, will
27 also be submitted for UV screening. At least 10 percent of the samples will be
28 submitted for laboratory analyses of TCL VOCs, TCL SVOCs, TAL metals, TOC,
29 and explosives to verify the field results (Table 3).

30

31 The second phase subsurface field screening program consist of up to eight soil
32 borings (FTB-03 through FTB-10) located between the open steel tank and Dogwood
33 Brook; approximate locations are presented in Figure 7. The objective of the second
34 phase borings is to determine the lateral and vertical distribution of contamination.
35 The borings will be drilled and sampled in accordance with the first phase; however,
36 locations and final depths will be based on the results of the first phase. Generally,
37 the second phase borings will be drilled to the depths where contamination was
38 detected in first phase borings.

SECTION 4

4.2.2 Geotechnical Investigations

The following subsections discuss the rationale and approach of geotechnical investigations proposed for the FTTA. Except for the monitoring well survey, these investigations are part of the second phase and will be implemented only if required after the completion of the first phase.

4.2.2.1 Monitoring Wells/Groundwater Sampling. As part of the first phase field activities, an existing monitoring well survey will be performed to confirm their site identifications, locations, and physical integrities. Existing monitoring wells will be checked for their label/Site ID and location as compared to that indicated on Figure 7. Monitoring wells shall also be sounded for water depths and well bottoms. Sounding depths should be compared to those presented in Table 2. Monitoring wells that are mislabeled and cannot be accurately located from the field checking shall be resurveyed by a New Jersey-licensed land surveyor. Subsection 16.6 addresses the criteria to be used in determining if monitoring well surveying is needed.

If required, upon completion of the first phase, up to six monitoring wells are proposed to be installed in three nested pairs at the FTTA (FTG-01A/B, FTG-02A/B, and FTG-03A/B). The number and location of the wells will be based on the field screening analytical results and existing well locations. Each pair will have one water table well and one well screened above the first encountered confining unit. The deep wells will be installed using the mud rotary technique (see Subsection 16.3.3), while the shallow wells will be installed using 6.25-inch HSAs. The depths and screened intervals of the deep wells will be chosen based on the contaminants detected during the screening program. A soil sample from the well screen interval of each new monitoring well will be submitted for analysis of grain size distribution.

One round of groundwater samples will be collected from the three existing monitoring wells and six (proposed) new monitoring wells. Groundwater samples will be analyzed for TCL VOCs, TCL SVOCs, TAL metals (nonfiltered and filtered), TSS, and explosives (Table 2).

Concurrent with groundwater sampling, a complete round of groundwater level measurements will be taken from the new and existing monitoring wells and piezometers. In addition, in-situ hydraulic conductivity tests will be performed at the existing and new monitoring wells. Data collected from these tests, when combined

1 with the flow gradients and directions calculated from measured water levels, can be
2 used to estimate groundwater flow velocities in the vicinity of the wells.
3

4 **4.2.2.2 Piezometers.** Two piezometers (FTPIEZ1 and FTPIEZ2) are proposed to
5 be installed to determine the nature of the hydrologic connection between Dogwood
6 Brook and the groundwater. Piezometer locations are presented in Figure 7. The
7 piezometers will be installed using 4.25-inch HSAs and will be screened across the
8 water table estimated to be 3 feet bgs. These piezometers will not be sampled for
9 laboratory analyses.
10

11 **4.2.2.3 Surface Water/Sediment Investigations.** A surface water/sediment sampling
12 program will be conducted as part of the first phase investigation along the banks of
13 Dogwood Brook southeast of the FTTA. This sampling program will be conducted
14 to characterize both the FTTA and Transportation Motor Pool (TMP) (located
15 upstream on Dogwood Brook and east of the FTTA [see Section 6.0]) impacts to the
16 surface water and sediment of Dogwood Brook.
17

18 Five surface water/sediment samples will be collected for laboratory analyses
19 (FTD/FTW-01 through FTD/FTW-05) (Figure 7). Two samples will be collected
20 upstream of the FTTA, two will be collected adjacent to the FTTA, and one will be
21 collected downstream of the FTTA. The two upgradient samples will provide data
22 regarding potential contamination contributed by the TMP. The surface water/
23 sediment samples will be analyzed for TCL VOCs, TCL SVOCs, TAL metals, TOC
24 (sediment samples only), alkalinity/hardness (surface water only), PCBs, explosives,
25 and grain-size analyses (sediment only) (Table 4). Two staff gauges (FTSTAFF1 and
26 FTSTAFF2) will be installed and surveyed in Dogwood Brook adjacent to the
27 piezometers, if necessary.

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1 **5.0 GOLF COURSE LEAKING TANK AREA (SITE 4)**

2

3

1 The Golf Course Leaking Tank Area is located in the northwestern part of the
2 Cantonment Area (Figure 2). Before its removal, the leaking UST was located near
3 the golf cart storage area just inside the southwestern fence of the driving range
4 (Figure 6).

5

6

7 **5.1 PREVIOUS INVESTIGATIONS**

8

9 Several previous investigations have been conducted at the Golf Course Leaking
10 Tank Area. These investigations are discussed below in chronological order.

11 In 1984, Ft. Dix personnel observed an oily sheen on the surface of a pond south of
12 the golf course clubhouse. The source of the observed contamination was
13 determined to be a 1,000-gallon UST containing unleaded gasoline (see Figure 6).
14 In October 1984, the UST was removed. During tank removal, soil around the tank,
15 to the depth of the water table, was removed and disposed of.

16 IKW presented a report in 1985 detailing the findings of groundwater testing at the
17 Golf Course Leaking Tank Area. Nine borings were each drilled to 20 feet bgs and
18 groundwater samples were collected from the saturated zone. Laboratory analyses
19 of groundwater samples collected from three of these borings (A1, B1, and C1),
20 located within 10 feet of the former UST location, indicated concentrations of BTEX
21 up to 48.6 milligrams per liter (mg/L).

22 EA, under contract to USATHAMA, prepared a PA/SI of environmental conditions
23 at Ft. Dix, including the Golf Course Leaking Tank Area. The PA/SI Report
24 indicates that three groundwater monitoring wells (GLF-15, through GLF-17) were
25 installed and samples from these wells were analyzed for VOCs, SVOCs, and
26 pesticides. Analytical results indicate concentrations of ethylbenzene up to 680 µg/L,
27 total xylene up to 440 µg/L, and benzene up to 400 µg/L. No pesticides were
28 detected in groundwater.

29 Dames and Moore, under contract to USATHAMA, conducted an RI at the Golf
30 Course Leaking Tank Area (Dames and Moore, 1993). This investigation included
31 a soil gas survey, collection and analysis of 32 soil samples from 11 borings (SC-243
32 through SC-251), installation of four groundwater monitoring wells (GLF-52, 53, 73,

SECTION 5

1 74), collection and analysis of groundwater samples, and collection and analysis of
2 four surface water/sediment samples (SW/SE-105 through SW/SE-108). The soil
3 gas survey results indicated VOCs east of the golf course clubhouse. Results of soil
4 sample analyses for TPH revealed concentrations up to 558 ppm (SC-244).
5 Groundwater analyses indicated benzene at concentrations up to 3.96 ppm in well
6 GLF-53. Sediment analyses indicated total SVOC concentrations up to 18.8 ppm.
7
8

5.2 PROPOSED SCOPE OF WORK

10 Results of previous investigations at the Golf Course Leaking Tank Area indicate
11 groundwater contamination by gasoline constituents such as BTEX. Based on
12 comparisons among 1987, 1988, and 1990 groundwater sampling results, contaminant
13 concentrations appear to be decreasing with time in the vicinity of the former UST
14 location. Concentrations appear to be increasing in a downgradient direction toward,
15 and possibly beyond, GLF-74 (Dames and Moore, 1993).
16
17

18 The objectives of the RI for this site are to:

- 19 1. further define the extent of groundwater, surface water, and sediment
20 contamination,
- 22 2. assess the risk to human health and the environment associated with
23 contamination, and
- 25 3. provide adequate data for assessment of remedial alternatives.

27 The proposed scope of work presented in the following subsections is based upon
28 these objectives, and the results of previous investigations.
29
30

5.2.1 Site Topographic Base Map

33 To better evaluate existing conditions at the Golf Course Leaking Tank Area and
34 facilitate any remediation of this site, an accurate base map will be prepared. The
35 map should be prepared before conducting fieldwork at the site to facilitate locating
36 proposed explorations. This map will accurately portray all existing structures at the
37 site including roads, buildings, utilities, fences, water courses, monitoring wells, fuel
38 storage structures, tree lines, and so forth. In addition, the base map shall include
39 ground surface topography with two-foot contour intervals. The mapped area shall

1 extend to the POL Area (see Subsection 3.2.1 of this Technical Plan). The map shall
2 be presented in hardcopy and CAD compatible computer disk file(s). The map shall
3 use the UTM system for horizontal grid markings. The topographic contours shall
4 be based on NGVD of 1929. This activity shall be coordinated with the field
5 checking of existing monitoring wells (see Subsection 5.2.3.1 of this Technical Plan).

6

7 **5.2.2 Field Screening**

8

9 Geoprobe/screened auger sampling of groundwater and field screening for BTEX,
10 pesticide, and lead is proposed for the Golf Course Leaking Tank Area. Geoprobe/
11 screened auger sampling and field screening will provide data for: (1) delineation
12 of the horizontal and vertical distribution of BTEX, pesticide, and lead in
13 groundwater, and (2) placement of new monitoring wells. Specific details of
14 geoprobe/screened auger sampling procedures and field analytical operations are
15 discussed in Sections 16.0 and 17.0, respectively, of this Technical Plan.

16 It is anticipated that up to three transects of geoprobe/screened auger sampling
17 points may be required at the Golf Course Leaking Tank Area with up to 21
18 explorations (GTA-01 through GTA-21). The first transect includes a series of seven
19 geoprobe/screened auger sampling locations, distributed uniformly in the shaded
20 area indicated in Figure 6. Subsequent geoprobe/screened auger transects and the
21 location of sampling points within transects will depend on the analytical results of
22 the first transect. The proposed location of the second geoprobe/screened auger
23 transect is also indicated in Figure 6. The second transect has been proposed for this
24 location due to detection of BTEX in monitoring well GLF-52. Installation and
25 location of the third transect will depend upon analytical results from the first and
26 second transects. It is estimated that five groundwater samples will be collected from
27 each geoprobe/screened auger exploration. The maximum depth of sampling is
28 anticipated to be 25 feet bgs. Depth to groundwater in the vicinity of the Golf
29 Course Leaking Tank Area is anticipated to be 5 to 10 feet bgs.

30
31 Field screening samples will be analyzed for BTEX, pesticides by a field GC.
32 Samples will also be collected for laboratory analyses of lead (filtered and unfiltered)
33 as well as TSS. At least 10 percent of the samples will be submitted for confirmatory
34 laboratory analysis of TCL VOCs, TCL SVOCs, TPH, pesticides, and herbicides
35 (Table 2).

SECTION 5

5.2.3 Geotechnical Investigations

The following subsections discuss the rationale and approach of geotechnical investigations proposed for the Golf Course Leaking Tank Area.

5.2.3.1 Monitoring Wells/Groundwater Sampling. Prior to new monitoring well installation, an existing well survey will be performed to confirm site identification, location, and physical integrity. Existing monitoring wells shall be checked for their label/Site ID and location as compared to that indicated on Figure 6. Monitoring wells shall also be sounded for water depths and well bottoms. Sounding depths should be compared to those in Table 2. Monitoring wells that are mislabeled and cannot be accurately located from the field checking shall be resurveyed by a New Jersey-licensed land surveyor. Subsection 16.6 addresses the criteria to be used in determining if monitoring well surveying is needed.

Up to 12 monitoring wells will be installed at the Golf Course Leaking Tank Area. The number and location of wells will be based on field screening analytical results and existing well locations. Eight of the wells are proposed to be installed in four clusters (GTG-01A/B, GTG-02A/B, GTG-03A/B, GTG-04A/B). The purpose of these clusters is to assess vertical distribution of contaminants and vertical hydraulic gradients. Each pair will have one water table monitoring well and one monitoring well screened above the first encountered confining unit. The deep wells will be installed using the mud rotary technique, while the shallow (water table) wells will be installed using HSAs. A natural gamma and EM conductivity borehole logging survey will be conducted in each of the four deep wells, drilled with mud rotary techniques, to assist in defining the geologic setting.

The remaining four shallow (water table) wells will be installed at the site beyond the expected plume boundary to allow for sampling of uncontaminated groundwater (GTG-05 through GTG-08). The locations and numbers of these shallow wells will be based upon results of field screening (Subsection 5.2.2). A soil sample from the well screen interval of each new monitoring well will be submitted for analysis of grain size distribution.

One round of groundwater samples will be collected from the seven existing monitoring wells and 12 (proposed) new monitoring wells. Groundwater samples will be analyzed for TCL VOCs, TCL SVOCs, TAL inorganics (nonfiltered and filtered), TPH, pesticides, herbicides, five-day biochemical oxygen demand (BOD-5), chemical oxygen demand (COD), TSS, total dissolved solids (TDS), nitrate/nitrite, sulfate,

1 phosphate and alkalinity/hardness (Table 2). Pesticide and herbicide analyses are
2 proposed based on potential contamination associated with Site 15 - Golf Course
3 Pesticide Mixing and Storage Area (see Section 15.0 of this Technical Plan). The
4 BOD-5, COD, nitrate/nitrite, sulfate, phosphate and alkalinity/hardness are included
5 to assist in development of the FS.

6 During groundwater sampling, a complete round of groundwater level measurements
7 will be taken from all new and existing wells. In addition, surface water levels will
8 be obtained from the three staff gauges (see Subsection 5.2.3).

9
10 **5.2.3.2 Aquifer Testing.** In-situ hydraulic conductivity testing (slug testing) will be
11 conducted at the site on all newly installed wells to estimate the hydraulic
12 conductivity of the aquifer. Data collected from these tests, when combined with
13 flow gradients and directions calculated from measured water levels can be used to
14 estimate groundwater flow velocities.
15

16 To develop estimates of aquifer parameters, an aquifer test will be conducted on one
17 of the monitoring wells at the Golf Course Leaking Tank Area. This test will consist
18 of a variable rate step test followed by a constant rate long term test. The
19 procedures for this test, outlined below, have been prepared in general accordance
20 with USEPA Suggested Operating Procedures for Aquifer Pumping Tests (USEPA,
21 1993). One of the new monitoring wells to be installed as part of this RI will be
22 used as the pumping well. The pumping well will be located as far as practicable
23 from the Golf Course Ponds (greater than 100 feet) to limit their influence on the
24 pumping test. Care will be taken to avoid starting or stopping the tests during or
25 immediately after precipitation events.
26

27 **Background Monitoring.** Prior to initiating the step drawdown test, background
28 groundwater levels will be monitored (hourly) to assess water level trends for a one
29 to two week period. This monitoring will be conducted in a background well
30 (located away from the site but within a similar geologic setting), in the pumping
31 well, and in a nearby well. Barometric pressure changes as well as precipitation
32 events will also be monitored (these may be available from the McGuire AFB
33 weather station).
34

35 **Step Drawdown Tests.** During the step drawdown test, the well to be used in the
36 long term monitoring test, will be pumped at successively higher rates over three to
37 five separate steps. During each step the water level drawdown in the pumping well
38 will be measured with a pressure transducer and data logger. The time between
39

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1 measurements will increase logarithmically over the course of each step. The
2 following are minimum data collection intervals to be used during the step test and
3 long term test:

	Elapsed Time (minutes)	Frequency of Measurement
6	0-1	15 seconds
7	1-5	30 seconds
8	5-10	1 minute
9	10-30	2 minutes
10	30-60	5 minutes
11	60-120	10 minutes
12	120-180	20 minutes
13	180-240	30 minutes
14	240-1440	1 hour
15	1440-end of test	4 hours

16 Each step will last from one to three hours, depending on water level response. At
17 the final step, the well will be pumped at the maximum rate possible without
18 threatening to expose the bowls of the pump. Given an expected specific capacity
19 of up to two gallons per minute per foot of drawdown and a typical 15 foot water
20 column in the monitoring wells at this site, it is expected that the maximum discharge
21 rate available in the pumping well will be on the order of 25 to 30 gallons per
22 minute.

23
24 At the conclusion of the step test, water level recovery in the pumping well will be
25 monitored to within 95 percent of pretest levels (accounting for any trend correction).
26 Results of the step test will be reviewed to select an optimum pumping rate for the
27 long term test. Selecting a constant rate test will require striking a balance between
28 maximizing stress to the aquifer and ensuring that adequate static head remains in
29 the extraction well to enable pumping to continue if a negative boundary is
30 encountered during the test. The long term test will not begin until complete
31 recovery from the step test is achieved. It is expected that there will be a one to two
32 week period between the step test and the long term test.
33

1 Long Term Aquifer Test. During the long term test, groundwater will be pumped
2 at a constant rate for a period up to 72 hours. The pumping period may be
3 shortened or extended if the water level data indicates steady state is reached in a
4 shorter time frame, or if data at the conclusion of the test indicate delayed responses
5 (delayed yield drainage or inadequately defined boundary conditions) are present.
6

7 Water levels will be measured in the pumping well and between 5 to 11 select
8 monitoring wells, this includes a combination of existing monitoring wells GLF-15,
9 GLF-16, GLF-17, GLF-52, GLF-53, GLF-73, GLF-74, and the new monitoring wells.
10 Background monitoring of these wells will be conducted as appropriate to correlate
11 to the background monitoring well. Specifications of the wells being monitored,
12 including drilling technique, well diameter, screen length, and screen location within
13 the site geologic setting will be developed. Water level monitoring frequencies will
14 again be logarithmic as tabulated above.
15

16 At the conclusion of the long term test, water levels will again be monitored in the
17 select wells until recovery has reached a minimum of 95 percent of the prepumping
18 water levels (adjusted for background trend). Monitoring of the background water
19 level will be continuous from approximately one week before the step test until
20 completion of recovery from the long term test.
21

22 Discharge Water Management. Water generated during the step test and long term
23 test will be stored on-site. This water will be treated with activated carbon to
24 remove site related contaminants. To document the performance of the activated
25 carbon system, up to three samples of treated groundwater will be sampled and
26 analyzed for TCL VOCs, TCL SVOCs, TAL metals, and pesticides. Following
27 receipt of the water quality analyses the treated groundwater will be disposed at the
28 Fort Dix waste water treatment plant.
29

30 Aquifer Test Analyses. The aquifer test analyses will evaluate both drawdown and
31 recovery data. The analyses will account for influences such as partial penetration,
32 barometric efficiency, and background water level trends. Factors such as delayed
33 yield (characteristic of unconfined aquifers), and leakage (possibly associated with
34 recharge the Golf Course Ponds) will also be assessed. Analytical techniques will be
35 based on the data obtained from the test and will likely include semi-log straight line
36 analyses as well as log-log curve matching.
37

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1 **5.2.3.3 Surface Water/Sediment Investigations.** A surface water/sediment
2 assessment program will be conducted in the site vicinity to obtain a preliminary
3 indication of contaminant impacts to these environments. The assessment program
4 consists of the following components: (1) sampling and analysis of surface water/
5 sediment samples from nine locations in the ponds and upgradient stream,
6 (2) establishing three staff gauges in the ponds to measure surface water levels, and
7 (3) coring and permeameter testing of two sediment samples from the pond bottoms
8 to be used in evaluating hydraulic connection of the ponds with the underlying
9 aquifer. Locations of these investigations are indicated in Figure 6.

10
11 Nine surface water/sediment samples (GTD/GTW-01 through GTD/GTW-09) will
12 be collected for laboratory analysis. Three samples will be collected upstream of the
13 northernmost pond (Figure 6). These 3 samples will provide upgradient data for
14 delineation of site-related impacts particularly for pesticides that are the
15 contaminants of concern for Site 15 - Golf Course Pesticide Storage and Mixing Area
16 (see Section 15.0). The remaining six samples will be collected from the ponds in
17 the vicinity of the site (see Figure 6). All surface water and sediment samples will
18 be analyzed for TCL VOCs, TCL SVOCs, TAL inorganics (nonfiltered), alkalinity/
19 hardness (surface water only), PCBs, pesticides, herbicides, TOC (sediment only), and
20 grain-size analyses (sediment only) (Table 4).

21
22 Three staff gauges (GTSTAFF1 through GTSTAFF3) will be installed in the ponds
23 to measure surface water levels (Figure 6). Measurements from these gauges will
24 provide data for assessment of hydrologic and hydrogeologic interaction.

25
26 Two sediment core samples will be collected for laboratory permeameter testing.
27 Permeameter tests will provide vertical permeability estimates for assessment of
28 hydraulic connection between the ponds and the underlying aquifer.

30 **5.2.4 Groundwater Modeling**

31
32 The conceptual geologic and hydrogeologic model of subsurface conditions at the
33 Golf Course Leaking Tank Area will be augmented through aquifer testing and
34 development of a groundwater flow/particle tracking model and a contaminant
35 transport model. This modeling effort is needed, as it is anticipated that groundwater
36 remediation will be required. The groundwater flow model will consist of a
37 mathematical numerical model coupled with a particle tracking package to simulate
38 groundwater flow conditions at the site. The contaminant transport model will utilize

SECTION 5

the calculated head distribution from the groundwater flow model to generate groundwater flow velocities and fluxes in the solution of the solute transport equation. The modeling effort will be used as a tool in evaluating the groundwater flow system and provide a mathematical framework for describing contaminant distribution and migration at this site. Overall, this will assist in the development of an adequate understanding of the groundwater flow system for completion of a comprehensive RI/FS at the Golf Course Leaking Tank Area.

The overall modeling tasks include:

- Model Development and Calibration
- Simulation of Remedial Alternatives
- Evaluation of Results and Reporting (to be included in the RI and the FS Reports)

The USGS Modular Three-Dimensional Finite Difference Groundwater Flow Model (MODFLOW) code (McDonald and Harbaugh, 1988) and the USGS particle tracking program MODPATH (Pollock, 1989) will be used to numerically simulate groundwater flow and advective transport at the site. MODFLOW is currently the most widely used groundwater flow model in the modeling community. MODFLOW is a finite difference numerical model with the capability to simulate groundwater flow, advective transport, complex boundary conditions, and which can simultaneously evaluate various remedial alternatives to support the FS. MODPATH interfaces with MODFLOW, simulating flow lines by computing particle pathlines. MODPATH uses MODFLOW output to calculate changes in particle positions over time.

Conceptually, the numerical model will have closely spaced nodes at the Golf Course Leaking Tank Area to facilitate the evaluation of various remedial alternatives and allow for a more accurate model calibration. Outside the source area, the model will have a coarser node spacing. It is anticipated that the model will consist of two or more layers depending on an evaluation of hydrogeologic and contaminant distribution data, and incorporate appropriate constant-head or specified flux boundaries in the model. The U.S. Army understands that the use of MODFLOW intrinsically implies to the USEPA that any or all MODFLOW packages will be employed as necessary to this site. MODFLOW packages likely to be used as part of this effort include the Basic Package, the Block-Centered Flow Package, the Well Package, the Recharge Package, the River Package, and one or more solver packages. Aquifer test results will also serve to validate the model.

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1 USEPA has requested that the contaminant transport model be constructed using the
2 MT3D model code. MT3D, developed by C. Zheng of S.S. Papadopoulos and
3 Associates (S.S. Papadopoulos, 1992), utilizes the calculated head distribution from a
4 groundwater flow model (MT3D is specifically designed for compatibility with
5 MODFLOW) to generate groundwater flow velocities and fluxes in the solution of
6 the solute transport equation. MT3D uses a number of solution techniques,
7 principally based on the method of characteristics (MOC). Depending on the
8 Courant number, indicating the degree of dominance of advective transport, MT3D
9 can use the MOC approach, a modified MOC (MMOC), or a hybrid of the two.
10 MT3D allows the user to incorporate dispersion in three dimensions, retardation due
11 to partitioning, and reaction of the solute in the modelled system. MT3D can be
12 applied to steady-state or transient solutions of the flow and transport systems. The
13 purpose of the transport model is to provide a numerical framework for describing
14 contaminant distribution and migration at the site.

15 To adequately document the model application and results at the Golf Course
16 Leaking Tank Area, the following outline, based upon QA procedures developed at
17 the Holcomb Research Institute, is presented. The final report will be structured
18 around this format with appropriate revisions.

- 21 • Purpose: state goals and objectives.
- 22 • Conceptual Model: present geologic and hydrogeologic environment
23 with an emphasis on identifying the controlling parameters and
24 boundary conditions for the hydrogeologic system.
- 25 • Data Collection: describe data collection and interpretation from
26 boring logs, slug tests, available literature, and so forth.
- 27 • Model Description: document model codes applied at Golf Course
28 Leaking Tank Area.
- 29 • Model Parameters: discuss initial conditions, boundary conditions as
30 well as hydraulic parameters, as appropriate.
- 31 • Model Calibration: present procedures and results of calibration as
32 related to targets.

SECTION 5

- 1 • Sensitivity Analysis: discuss parameter sensitivity as related to model
- 2 application and influence on model results.
- 3
- 4 • Model Validation: comparison of model results with observed field
- 5 conditions. This will include sum of the squares of the residuals and
- 6 scattergram plots of head differentials.
- 7
- 8 • Data Processing: document pre- and post-processing applied to data
- 9 inputs and results.
- 10
- 11 • Model Prediction: presentation of predictive scenarios.
- 12
- 13 • Model Results: evaluate how model results verify the conceptual
- 14 model (modified as necessary) and the quantification of the flow
- 15 regime as it pertains to the predictive scenarios. This will include
- 16 capture zone analysis.
- 17
- 18 • Model Records: supply records of model runs on hard copy or disk as
- 19 requested.

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6.0 TRANSPORTATION MOTOR POOL (SITE 5)

The Transportation Motor Pool (TMP) is a paved, active, fuel dispensing, and vehicle parking facility located in the north central part of the Cantonment Area (Figure 3). The TMP is bordered by West First Street to the south, Delaware Avenue to the east, Pennsylvania Avenue to the west and Headquarters Street to the north.

6.1 PREVIOUS INVESTIGATIONS

In 1985, IKW (IKW, 1986) conducted an investigation at the TMP fuel-dispensing facility. The investigation consisted of four soil borings to depths of 20 feet with continuous sampling. The borings were located north of two fuel pump islands that included a former leaking pump. Soil samples from the borings were submitted for TPH analysis by water and Freon extraction. In addition, water samples were collected from each soil boring at the water table and the bottom of each boring and were analyzed for VOCs and TPH. Surface water samples were collected at four locations on a daily basis for seven consecutive days and analyzed for VOCs. Surface water samples were collected at: (1) the sump (catch basin), (2) the outlet of Dogwood Lake drainage ditch, (3) the outlet of the drainage ditch off Pennsylvania Avenue, and (4) the outlet of the drainage ditch between the pine tree nursery and the parking area off Delaware Avenue.

Results of the IKW investigation indicated that TPH were detected in soils in borings E-3, F-3, G-3, and H-3, with highest detections occurring in a surface soil sample from boring G-3 (3,800 mg/kg). Sporadic TPH detections were noted below the water table. No VOCs were detected in the groundwater, surface water, and sediment samples collected at the TMP.

A PA/SI (EA, 1989) was conducted at the TMP. Three wells were installed, sampled, and analyzed for VOCs and SVOCs at the TMP as part of this PA/SI. No contaminants were detected in monitoring well TMP-21. Chloroform (8 µg/L) was detected once in two rounds of sampling at well TMP-22. Fluorene (40 µg/L), phenanthrene (100 µg/L), and pyrene (20 µg/L) were detected in one sample from the flush-mount monitoring well TMP-23. The PA/SI indicated that contaminants detected at TMP-23 were likely the result of well TMP-23 being contaminated by paving operations. Monitoring well TMP-23 was abandoned by grouting and replaced with a new monitoring well (TMP-55) during the Phase I RI.

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1 During the RI, three additional 25-foot deep wells (TMP-54 through TMP-56) were
2 installed by Dames and Moore (1993) (Figure 7). The new and existing wells were
3 sampled and analyzed for VOCs. In addition, two surface water and sediment
4 samples were collected and analyzed for VOCs (Figure 7). Sediment samples were
5 analyzed for TOC. Groundwater was interpreted to flow both northeast and
6 southeast toward the storm sewer transecting the southern half of the TMP. Because
7 the site is paved, runoff was determined to flow southward for collection by the storm
8 sewer system.

9 Dames and Moore reported that chloroform was detected in groundwater at existing
10 monitoring well TMP-22 (1.34 µg/L) and in new monitoring wells TMP-54
11 (2.06 µg/L) and TMP-56 (5.57 µg/L). Methylene chloride was also detected at
12 TMP-56 (6.53 µg/L). Methylene chloride was associated with field blanks collected
13 at this site. No VOCs were detected in the surface water samples. Acetone detected
14 in two sediment samples was attributed to laboratory contamination. TOC found in
15 the most downstream sediment sample was associated with TPH that had been found
16 at the site. This sample also could have contained a large percentage of natural
17 organic matter.

6.2 PROPOSED SCOPE OF WORK

21 Results of previous investigations at the TMP do not conclusively confirm or
22 eliminate the potential that past practices have not impacted groundwater at the
23 TMP. Sampling and analysis by IKW indicates that a source of petroleum-related
24 contaminants was and still may be present at the TMP. Also, existing wells at the
25 TMP may not be strategically located to intercept groundwater contamination caused
26 by the potential source described by the IKW Report. A summary of the field
27 activities to be conducted at this site are presented in Table 1.

28 The objectives for the RI for this site are to:

- 31 1. determine if groundwater contamination exists at the TMP,
- 32 2. characterize the extent and distribution of groundwater contamination
33 if it exists, and
- 34 3. assess the risk to human health and the environment associated with
35 this contamination.

1 6.2.1 Field Screening

2
3 The field screening program consists of the collection of both subsurface soils and
4 groundwater samples to be field screened for BTEX and TPH. The objective of the
5 field screening program is to determine if residual contamination identified in the
6 IKW study still exists.

7
8 **6.2.1.1 Soil Field Screening.** Up to 10 soil borings (TMB-01 through TMB-10) will
9 be drilled with 4.25-inch HSAs to depths of approximately 25 feet bgs. Samples will
10 be collected continuously and will be field screened for BTEX by GC and TPH by
11 IR (Table 3). Soil samples collected at or just above the water table, as well as just
12 above confining layers, will also be submitted for UV screening. The soil borings will
13 be located in the vicinity of previous borings E3, F3, G3, and H3 where sporadic
14 TPH detections below the watertable were encountered (Figure 7). At least
15 10 percent of the samples will be submitted for laboratory analyses of TCL VOCs,
16 TCL SVOCs, TAL metals, TPH, and TOC to verify the field results.

17
18 Up to three tests pits (TMS-01 through TMS-3) will be excavated adjacent to the
19 buried storm sewer (Figure 7). The objective of these test pits is to determine if the
20 storm sewer, which traverses the southern portion of the TMP area from west to east,
21 is providing a preferential flow path for TMP-related contaminants. Up to two
22 samples of pipe bedding material/soils from each test pit will be collected and field
23 screened for BTEX and TPH (Table 3).

24
25 Approximately one sample from each test pit will be submitted for laboratory
26 analyses of TCL VOCs, TCL SVOCs, TAL metals, TPH, and TOC to verify the field
27 results.

28
29 **6.2.1.2 Groundwater Field Screening.** Up to ten screened auger/geoprobe borings
30 (TMA-01 through TMA-10) will be installed to collect groundwater samples for field
31 screening. Samples will be collected at five foot intervals beginning at the
32 groundwater table and continuing to a maximum depth of approximately 25 feet bgs,
33 and will be field screened for BTEX, chlorinated solvents (chloroform), and TPH.
34 The borings will be located in the vicinity of previous borings E3, F3, G3, and H3
35 (Figure 7). Depth to groundwater in this area is anticipated to be 10 feet bgs. At
36 least 10 percent of the samples collected for screening will be submitted for
37 laboratory analyses of TCL VOCs, TCL SVOCs, TAL metals (nonfiltered and
38 filtered), TPH, and TSS to verify the field results.

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6.2.2 Geotechnical Investigations

The following subsections discuss the rationale and approach of geotechnical investigations proposed for the TMP. Monitoring wells will be installed only if the groundwater field screening program indicates contamination.

6.2.2.1 Monitoring Wells/Groundwater Sampling. Prior to new monitoring well installations, an existing survey should be performed to confirm site identification, location, and physical integrity. Existing monitoring wells shall be checked for their label/Site ID and location as compared to that shown on Figure 7. Monitoring wells will also be sounded for water depths and well bottoms. Sounding depths shall be compared to those presented in Table 2. Monitoring wells that are mislabeled and cannot be accurately located from the field checking shall be resurveyed by a New Jersey-licensed land surveyor. Subsection 16.6 addresses the criteria to be used in determining if monitoring well surveying is needed.

If required, upon completion of the field screening program, up to three groundwater monitoring water table wells (TMG-01 through TMG-03) are proposed to be installed at the TMP. The final number and location of the wells will be based on the field screening analytical results. The wells will be installed using 6.25-inch HSAs to a depth estimated to be 25 feet bgs, although if groundwater contamination is detected at the water table the new well screens will be positioned to intersect the water table. A soil sample from the well screen interval of each new monitoring well will be submitted for analysis of grain size distribution.

One round of groundwater samples will be collected from the five existing and three new, if installed, monitoring wells, and will be analyzed for TCL VOCs, TCL SVOCs, TAL metals (nonfiltered and filtered), TSS, and TPH (Table 2). Concurrent with groundwater sampling, a complete round of groundwater level measurements will be taken from existing and new monitoring wells. In addition, in-situ hydraulic conductivity testing will be performed at the new monitoring wells. Data collected from these tests, when combined with the flow gradients and directions calculated from measured water levels, can be used to estimate groundwater flow velocities in the vicinity of the wells.

6.2.2.2 Surface Water/Sediment Investigations. The surface water and sediment program for the TMP will be conducted as part of the FTTA investigation presented in Subsection 4.2.2.3 of this Technical Plan.

1 **7.0 ARDC TEST SITE (SITE 6)**

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The Armament Research and Development Center (ARDC) Test Facility is located
in the Range and Impact Area near the northern Ft. Dix boundary approximately
2,000 feet west of Brindle Lake (Figure 2). The site, including nine buildings, has
been the location for testing and analysis of weapons at Ft. Dix. A wide variety of
small arms (up to 40 millimeter [mm]) weapons have been tested at this facility.
Testing generally evaluates the physical response of weapons and munitions to the
extreme physical conditions to which they may be exposed. This includes such tests
as: weapons firing at extreme temperatures, munition response to firing at high
pressures, measuring tracer firings, and measuring the penetration of bullets into
metal plates. The tests do not include mixing, storage, replacement, or disposal of
chemicals or radioisotopes. The only processes that have reportedly discharged
wastes at this site are the X-ray photographic processing laboratory and fuel storage
area.

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The photographic processing laboratory is located at the western end of the site
(Figure 8). The laboratory is currently equipped with a silver recovery unit. Before
the installation of this recovery unit, laboratory rinsewater from a microflash X-ray
process was allowed to drain onto the ground. This occurred for a two-year period
with typical discharges of 5 to 25 gallons per month. This area was investigated
during the Preliminary Assessment/Site Investigation for Fort Dix (EA, 1989). The
results of the PA/SI indicated this area was uncontaminated. As such, it is not
considered part of this investigation.

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The second potential contaminant source is a fuel storage area at the southeast end
of the site, where a spill of approximately 25 gallons of diesel fuel occurred in 1984.
The fuel storage area includes two aboveground gasoline tanks and four 55-gallon
drums used to store waste oil. As part of a previous remedial measure, the first foot
of soil was removed from this area and replaced with clean fill. However, staining
of the ground surface was still visible during a site visit in September 1987, suggesting
either incomplete removal or new spillage following the remedial action.

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32
33
7.1 PREVIOUS INVESTIGATIONS

34
35
During the PA/SI, a series of seven surface soil grab samples and one surface soil
composite sample were collected. Three grab samples were collected near the

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1 photoprocessing shop. The remaining four grab samples, including one duplicate and
2 the composite sample, were collected near the fuel storage area. Samples from the
3 photoprocessing shop were analyzed for VOCs, SVOCs and inorganics. No VOCs
4 or SVOCs were detected in any of the samples. Selected metals were detected
5 although all concentrations are below the NJDEP-proposed soil cleanup criteria. Soil
6 samples from the fuel storage area were analyzed for TPH. These results indicated
7 TPH concentrations from 140 to over 436 mg/kg. Based on these results, the Phase
8 I and Phase II RI were developed.

9 The Phase I and Phase II RI focused on potential contamination associated with the
10 fuel storage area. During the Phase I RI, soil samples were collected from zero,
11 three and occasionally six feet bgs at 17 locations (SC-128 through SC-144)
12 (Figure 8). All soil samples were analyzed for TPH and a few select samples were
13 analyzed for VOCs and SVOCs to determine the distribution of soil contamination.
14 During the Phase II field program, nine additional soil samples were collected at
15 depths of 0 to 10 feet from three monitoring well borings (ARD-75 through
16 ARD-77). These soil samples were analyzed for VOCs and TPH.

17 Three 20-foot deep shallow water table monitoring wells (ARD-75, ARD-76, and
18 ARD-77) were installed and sampled during the Phase II RI field program. The
19 potable water well (FTDIX-13), located in Building 9990 at the center of the site,
20 was also sampled. In addition, three surface water and three sediment samples were
21 collected to establish whether contaminants had impacted surface water. Samples
22 were collected from three locations (SW/SE-114, SW/SE-115, and SW/SE-116)
23 along the drainage ditch that directs surface water flow to the northeast, past the fuel
24 spill area (see Figure 8).

25 Analytical results from the Phase I and Phase II soil sampling programs indicated
26 substantial TPH contamination in the vicinity of the fuel storage area. The TPH
27 concentrations ranged from 22.4 to 48,439 mg/kg. The concentration of TPH
28 decreased with distance from the gas tanks, indicating that the source of petroleum
29 hydrocarbons in these borings is most likely the gasoline tanks. Concentrations of
30 TPH in these borings also decreased with depth, but levels as high as 15,289 mg/kg
31 were detected 3 feet bgs in boring SC-141.

32 An area of high TPH concentration was also observed upgradient of the oil drums,
33 indicating that a spill/leakage may have occurred in this area. The VOC and SVOC
34 analyses of soil samples also indicate that concentrations of toluene, ethylbenzene,
35 xylene, acetone, and 2-methylnaphthalene generally decrease with distance from the

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1 oil drums. This suggests that leaks/spills from the drums may have caused the
2 contamination. The chlorinated solvents detected during the Phase I and Phase II
3 soil sampling program include 1,2-dichloroethylene, 1,1,2,2-tetrachloroethane,
4 tetrachloroethylene, trichloroethylene, and trichlorofluoromethane. The maximum
5 concentration of these individual compounds was 0.2 mg/kg of tetrachloroethylene
6 detected in soil samples from three and six feet bgs at SC-142, located approximately
7 40 feet downgradient (southeast) from the fuel storage (see Figure 8). The maximum
8 concentration of the sum of these compounds was 0.341 mg/kg which was also
9 detected in a soil sample from SC-142 (six feet bgs).

10
11 The chlorinated VOCs, were also detected in soil samples from three and six feet bgs
12 at SC-143 and SC-144, located approximately 90 to 110 feet downgradient from the
13 fuel storage area. The concentrations detected in SC-143 and SC-144 was slightly
14 lower then those measured at SC-142.

15
16 Chlorinated VOCs were not detected in soil samples from SC-141, located adjacent
17 to the fuel storage area.

18
19 Analytical results from the groundwater sampling program indicated the presence of
20 TPH in monitoring well ARD-76 and FTDIX-13 (657 and 784 µg/L, respectively).
21 TPH in ARD-76 may be due to dispersion from the spill area, which is approximately
22 50 feet to the northeast, or because a low groundwater gradient exists in the area and
23 flow direction may change periodically with variation in recharge conditions.
24 FTDIX-13 supplies ARDC with production water. This well is located approximately
25 150 feet northwest of the fuel storage area. Because FTDIX-13 is 240 feet deep and
26 probably screened at depths well below the Kirkwood Formation, it is unlikely that
27 the detected TPH originates from the fuel storage area, especially as the Kirkwood
28 formation is believed to overlie the Manasquan Formation, a confining bed. VOCs
29 detected in groundwater were limited to ARD-76.

30
31 Analytical results from the surface water/sediment sampling program indicated TPH
32 concentrations were lowest in upstream sediment (SE-114 93.7 mg/kg) and increased
33 in the two downstream locations (SE-115 104.6 mg/kg and SE-116 416 mg/kg). The
34 closest sampling location to the spill area (SE-115) also exhibited xylene and
35 trichloroethene. Xylene at 0.027 mg/kg was below the New Jersey Action Level
36 (NJAL), while trichloroethene at 2.43 mg/kg exceeded the NJAL of 1 mg/kg. The
37 only contaminant detected in surface water was trichloroethene (2.19 mg/kg) at the
38 downstream location SW-116.

SECTION 7

7.2 PROPOSED SCOPE OF WORK

Results of previous investigations indicated shallow surface soil contamination at the fuel storage area. In addition, there appears to be an impact on the nearby drainage ditch and possibly the surface water within the ditch. Groundwater impacts associated with the fuel storage area appear to be confined to monitoring well ARD-76 where TPH, ethylbenzene, and xylene were detected during the Phase II RI. In addition, the potable well FTDIX-13 has also shown detectable concentrations of TPH, although no other site-related contaminants were detected. A summary of field activities to be conducted at this site are presented in Table 1.

The objectives of this RI are to:

1. Define the nature and distribution of the surface soil impacts near the fuel storage area where substantial TPH concentrations have been detected in the past.
2. Assess the condition of the potable well FTDIX-13. This includes checking the physical condition of the well and pump, analytical sampling of the well, and pumping the well to evaluate its ability to affect shallow groundwater flow in the site vicinity.
3. Assess impacts to groundwater from the reported septic leachfield associated with Building 9990 where FTDIX-13 is located.
4. Install a monitoring well cluster to assist with the delineation of the water table configuration and assess potential vertical distribution of impacts from the fuel storage area.

7.2.1 Site Topographic Base Map

To better evaluate existing conditions at the ARDC, and facilitate any remediation of this site, an accurate base map will be prepared. The map should be prepared before conducting fieldwork at the site to facilitate fieldwork at this site. This map will accurately portray all existing structures at the site including roads, buildings, utilities, fences, water courses, monitoring wells, fuel storage structures, tree lines, etc. In addition, the base map shall include ground surface topography with two-foot contour intervals (this may require new photogrammetry to be performed). The map shall be presented in hardcopy and CAD compatible computer disk file(s). The map

1 shall use the UTM for horizontal grid markings with a 1-inch = 100-foot scale. The
2 topographic contours shall be based on NGVD of 1929. This activity should be
3 coordinated with the field checking of existing monitoring wells (see
4 Subsection 7.2.4.3 of this Technical Plan).

5

6 **7.2.2 Field Screening**

7

8 The field screening program consists of the collection of groundwater samples to be
9 field screened for BTEX and TPH. The objectives of this field screening program
10 is to evaluate the potential impact to soil and groundwater from the septic leachfield
11 associated with Building 9990, where FTDIX-13 is housed (Figure 8). It is
12 anticipated that up to five geoprobe/screened auger borings (ARA-01 through
13 ARA-05) will be completed in the vicinity of the leachfield to collect groundwater
14 samples. At each boring, up to two groundwater samples will be collected at
15 five-foot intervals beginning at the groundwater table (estimated to be five feet bgs).
16 Estimated sampling depth with the geoprobe/screened auger will be 25 feet bgs.
17 At each groundwater sampling interval samples will be collected for field screening
18 of BTEX and TPH. At least 10 percent of the field screening samples will be
19 submitted for confirmatory laboratory analyses of TCL VOCs, TCL SVOCs, TAL
20 metals (nonfiltered and filtered), TSS, and TPH (Table 2).

21

22 **7.2.3 Well FTDIX-13 Evaluation**

23

24 Laboratory analyses of groundwater samples from potable well FTDIX-13 have
25 shown detectable concentrations of TPH, up to 784 µg/L. This well is downgradient
26 from the fuel storage area. However, since the well is reportedly 240 feet deep, it
27 is unlikely that TPH contamination could migrate from the ground surface to this
28 depth. Prior to conducting an extensive analysis of the well condition, duplicate
29 samples will be collected from FTDIX-13 (FDIX1301 and FDIX1301D) and analyzed
30 for TCL VOCs, TCL SVOCs, TAL Metals (nonfiltered), TSS and TPH. These
31 samples will be collected from a spigot located as close as practicable to the well
32 head, preferably before any pressure tank and/or filters. These samples will be
33 collected concurrent with the source water sampling to expedite the analyses and
34 determine if a more extensive sampling program is necessary. The following program
35 (see Subsection 7.2.3.1) will further assist in defining the source of this contamination
36 and will be undertaken if the initial samples verify the historical TPH concentrations
37 at this well.

38

SECTION 7

1 **7.2.3.1 Pump Removal.** To evaluate the potential for the existing FTDIX-13 pump
2 to contaminate the samples, the pump shall be removed and the following activities
3 completed:

- 4 1. inspect the pump for cracks, oil leaks, worn materials, if the pump is
5 in disrepair and is replaced the typical sustained rate of the new pump
6 will be noted;
- 7 2. check water level for comparison with shallow water table elevation
8 (vertical survey of top of well casing required);
- 9 3. check for product;
- 10 4. sound the well bottom to verify reported well depth;
- 11 5. natural gamma logging of well to identify the presence and depth of
12 confining layer(s);
- 13 6. installation of a stilling tube to allow water level measurements;
- 14 7. if no product is observed, FTDIX-13 will be purged of three to five
15 well volumes and sampled for laboratory analysis of TCL VOCs, TCL
16 SVOCs, TAL metals (nonfiltered and filtered), TSS, and TPH (Site ID
17 FDIX1301).

25 **7.2.3.2 Pumping Test.** To assess hydraulic communication between FTDIX-13 and
26 the shallow water table aquifer, a 12-to-24-hour aquifer test shall be conducted on
27 FTDIX-13. The test shall consist of a constant rate discharge test with FTDIX-13
28 being pumped at its typical sustained rate. Care shall be taken to coordinate the test
29 with Ft. Dix personnel to ensure the pumped water can be adequately handled and
30 disposed.

32 During the test, the water level in FTDIX-13 and nearby monitoring wells shall be
33 measured to enable evaluation of hydraulic communication. The monitoring shall
34 be conducted in advance of the test to assess trends in water level fluctuation.

36 During the aquifer test time , groundwater samples (FDIX1302 through FDIX1310)
37 will be collected from FTDIX-13 to assess changing TPH concentrations over time.
38 Samples will be collected at the beginning of the test as well as at 0.5, 1, 2, 4, 8, 16,

1 and 24 hours and at the end of the aquifer test. The samples shall be submitted for
2 laboratory analysis of TPH. The initial, one hour and final sample shall also be
3 submitted for laboratory analysis of TCL VOCs, TCL SVOCs, TAL metals
4 (nonfiltered and filtered), TPH, and TSS. These samples will be collected at the
5 spigot nearest the pump to avoid sampling of water after it has passed through filters
6 or pressure tanks. If the analytical results from the pumping test and activities
7 associated with pump removal suggest the well casing is cracked, then additional
8 efforts may be undertaken to assess the integrity of the casing (e.g., caliper and/or
9 televIEWER logging).

10

11 **7.2.4 Geotechnical Investigations**

12

13 **7.2.4.1 Surface Soil Sampling.** Up to 10 surface soil samples (ARS-01 through
14 ARS-10) will be collected from the area near the fuel storage area to further
15 delineate surficial contamination in this area. Proposed sample locations are
16 presented in Figure 8. At each sampling location, a two to three feet deep hole shall
17 be manually excavated and logged. One sample shall be collected from each
18 excavation and submitted for laboratory analyses of TCL VOCs, TCL SVOCs, TAL
19 metals, TOC, and TPH. The depth from which the sample is collected shall be based
20 upon field observations, and to the extent practicable, be oriented toward sampling
21 from contaminated soil horizons.

22

23 **7.2.4.2 Soil Borings.** Up to four additional soil borings (ARB-01 through ARB-04)
24 shall be drilled with 4.25-inch HSAs to the water table at the ARDC. These borings
25 are intended to assess the extent of shallow soil contamination above the water table
26 and identify LNAPL that may be situated above the water table. The borings will
27 be drilled to approximately 10 feet below the water table. The total soil boring
28 depth is estimated to be 15 feet bgs. Proposed locations for these soil borings are
29 presented in Figure 8, although their locations may be adjusted based on field
30 observations of the shallow surface soil samples.

31

32 Soil samples will be collected continuously with a split spoon sampler. Up to three
33 soil samples from each soil boring will be submitted for laboratory analyses. Samples
34 selected for laboratory analyses will be based on field observations, such as elevated
35 photoionization detector (PID) readings, sample discoloration, unusual odors, and so
36 forth. However, if no significant field observations are noted, the samples will be
37 collected from 10 feet bgs, the water table, and the bottom of the boring. Samples
38 submitted for laboratory analyses shall be analyzed for TCL VOCs, TCL SVOCs,
39 TAL metals, TOC, and TPH.

SECTION 7

1 **7.2.4.3 Monitoring Wells/Groundwater Sampling.** Prior to new monitoring well
2 installation, an existing well survey should be performed to confirm site identification,
3 location, and physical integrity. Existing monitoring wells will be checked for label/
4 Site ID and their location as compared to that shown on Figure 8. Sounding depths
5 shall be compared to those presented in Table 2. Monitoring wells that are
6 mislabeled and cannot be accurately located from the field checking will be
7 resurveyed by a New Jersey-licensed land surveyor. Subsection 16.6 addresses the
8 criteria to be used in determining if monitoring well surveying is needed.
9

10 Efforts will be made to collect water level data to assess the level of influence that
11 production well FTDIX-13 has on the shallow water table. This will be accomplished
12 by collecting two separate rounds of water level data at this site. Prior to the first
13 round, well FTDIX-13 will be shut down for one to five days (to the extent
14 practicable). This will give an indication of the natural groundwater flow directions
15 and gradients. The second round will be collected just prior to shutting down the
16 aquifer test described in Subsection 7.2.3.2. This will give an indication of
17 groundwater flow directions and gradients under impact from FTDIX-13.
18

19 Two additional monitoring wells, one shallow (ARG-01A) and one deep (ARG-01B),
20 will be installed at the ARDC. The shallow monitoring well shall be installed to
21 better define the orientation of the water table surface in this area. Previous
22 investigations have indicated that shallow groundwater flow is toward the northwest.
23 However, there are only three monitoring wells available to develop this interpreted
24 flow direction. The proposed location for the shallow monitoring well is shown in
25 Figure 8. This location may be adjusted slightly based on the results of the surface
26 soil sampling and soil boring program. It is likely that the new monitoring well will
27 be generally located between the fuel storage area and Building 9990 (where
28 FTDIX-13 is located). The shallow monitoring well shall be drilled with 6.25-inch
29 HSAs and shall be screened across the water table with an approximate 10-foot long
30 well screen. A soil sample from the well screen interval of each new monitoring well
31 will be submitted for analysis of grain size distribution.
32

33 The deep groundwater monitoring well will be installed if the FTDIX-13 well
34 evaluation (Subsection 7.2.3 of this Technical Plan) indicates that TPH contamination
35 originates at the fuel storage area. The proposed location for the deep monitoring
36 well is between FTDIX-13 and the fuel storage area (Figure 8). The deep
37 monitoring well shall be installed below the first confining unit, expected to be the
38 base of the Kirkwood Formation and approximately 100 feet bgs. Because this well
39 will be installed below a confining unit, the boring will be double-cased and drilled

utilizing the mud rotary technique (see Subsection 16.3.3). Subsurface soil samples will be collected with a split-spoon sampler at five-foot intervals. A natural gamma and EM conductivity borehole logging survey will be conducted in the boring to assist in defining the geologic setting. The gamma logging produces better results if conducted in the borehole prior to the installation of casing. Therefore, the survey will be conducted in two phases, after completion of borehole to the confining unit but prior to the installation of casing and after the termination of the borehole and the installation of the monitoring well.

One round of groundwater samples will be collected from the three existing monitoring wells, the new monitoring well(s), and the production well FTDIX-13. Groundwater samples will be analyzed for TCL VOCs, TCL SVOCs, TAL metals (nonfiltered and filtered), TPH, and TSS (Table 2).

During groundwater sampling, a complete round of groundwater level measurements will be taken from new and existing monitoring wells. If access is available, the water level at FTDIX-13 will be measured. Surface water levels will be measured at the three staff gauges established on the drainage ditch south of the ARDC (see Subsection 7.2.4.4).

In addition, in-situ hydraulic conductivity testing will be performed at the new monitoring wells. Data collected from these tests, when combined with the flow gradients and directions calculated from measured water levels, can be used to estimate groundwater flow directions and velocities in the vicinity of the wells.

7.2.4.4 Surface Water/Sediment Investigations. A surface water/sediment sampling program will be conducted to further define the impacts to these environments. Three surface water/sediment sample pairs (ARD/ARW-01 through ARD/ARW-03) will be collected south and east of the previously sampled locations (SW/SE113, SW/SE114, and SW/SE116) as shown on Figure 8. These three samples will be field screened for BTEX, 111TCE, and TPH as well as being submitted for the laboratory analyses listed below. If the field screening results indicate the presence of BTEX, 111TCE, or TPH at concentrations above the ARARs listed in Table 12, then up to five additional surface water/sediment sample pairs (ARD/W-04 through ARD/W-08) will be submitted for laboratory analyses. Laboratory analyses for surface water/sediment samples will include TCL VOCs, TCL SVOCs, TAL inorganics, pesticides, PCBs, alkalinity/hardness (surface water only), TOC (sediment only) and grain-size distribution (sediment only).

SECTION 7

1 Surface water staff gauges (ARSTAFF1 through ARSTAFF3) will be installed
2 adjacent to each surface water/sediment sample pair to enable measurement of
3 surface water elevations. Water level measurements from these gauges will assist in
4 defining the degree of surface water/groundwater interaction.

1 **8.0 PESTICIDE CONTROL SHOP (SITE 8)**

2

3

1 The Pesticide Control Shop (Building 5352) is located in the northeast part of the
2 Cantonment Area, north of the fire house and east of Delaware Avenue (Figure 3).
3 The site was used for pesticide storage and consists of a small wood frame building
4 with two gravel areas adjacent to the northern side of the building. The remainder
5 of the area is a paved parking lot. The site was identified during investigations in
6 1975 and 1985 as a potential concern because of reported pesticide in soil. Details
7 of historic site operations are unknown. Locations of existing and proposed
8 investigations are presented in Figure 7.

9

10 **8.1 PREVIOUS INVESTIGATIONS**

11

12 The Pesticide Control Shop Site was studied by the USAEHA in 1975; distribution
13 of pesticides in selected media and receptors was evaluated. DDT, DDD, DDE, and
14 chlordane were detected in soil and sediment samples; however, the exact locations
15 of the sampling stations were not defined. In 1985, USAEHA conducted another
16 study to identify pesticide residues associated with the Pest Management Program at
17 Ft. Dix. The investigation included the collection and analysis of soil and sediment
18 samples. The maximum detected concentration of a total pesticide residue was
19 47.45 mg/kg.

20

21 Based on the results of the previous investigations, soil and sediment samples were
22 collected and analyzed for VOCs, SVOCs, and pesticides during the Phase I RI
23 program (Dames and Moore, 1993). Eighteen soil samples were collected from six
24 locations at depths of zero, 1.5, and 3.5 feet. One sediment sample was collected
25 from the storm drain, which collects runoff from the Pesticide Control Shop parking
26 lot.

27

28 Results of the Phase I RI program indicate VOCs detected at relatively low levels,
29 and SVOCs detected at relatively higher levels near the Pesticide Control Shop. In
30 general, pesticide concentrations were lower in the Phase I RI sampling than in the
31 1985 sampling. The exception to this trend was o,p'-DDD, for which maximum
32 detected concentrations were 2 mg/kg in 1985 compared to 6.90 mg/kg in 1988.
33 2,4-dinitrotoluene (DNT) was detected at a concentration of 0.322 mg/kg in one soil
34 sample at a depth of 1.5 feet. The source of the 2,4-DNT is not known.

35

SECTION 8

8.2 PROPOSED SCOPE OF WORK

Results of the previous investigations at the Pesticide Control Shop indicate surface and subsurface soil pesticide contamination. Groundwater quality has not been evaluated at this site.

The objectives of the RI for this site are to:

1. further define the distribution of soil, groundwater, surface water, and sediment contamination; and
2. assess the potential risk to human health and the environment associated with contaminants.

The proposed scope of work is to be implemented in a phased approach. The first phase focuses on field screening of subsurface soils and groundwater at the gravel areas adjacent to the Pesticide Control Shop to determine the presence or absence of contaminants. Surface water and sediment samples will also be collected. The second phase will consist of additional soil borings and installation of groundwater monitoring wells, if needed. The implementation of the second phase is contingent on contaminants being detected during the field screening program. A brief technical memorandum will be prepared at the conclusion of the first phase. This memorandum will summarize the results of the field screening program and detail the extent of the second phase, if required. This technical memorandum will be submitted to the USEPA to develop a consensus for any second phase of sampling and analyses needed at this site.

8.2.1 Field Screening

8.2.1.1 Soil Field Screening. During the first phase of field screening one soil boring will be drilled in each gravel area (PCB-01 and PCB-02). The soil borings will be drilled with 4.25-inch HSAs to a depth of 25 feet bgs. Soil samples will be collected continuously and field screened for BTEX and pesticides using a field GC and herbicides utilizing immunoassay tests. Soil samples collected at or just above the water table, as well as just above confining layers, will also be submitted for UV screening. At least 10 percent of the samples collected will also be submitted for confirmatory laboratory analyses of TCL VOCs, TCL SVOCs, TAL inorganics, pesticides, herbicides, and explosives (Table 3).

If the first phase field screening data suggest soil contamination, then a second phase will be undertaken. Up to six additional soil borings (PCB-03 through PCB-08) will be drilled in the parking lot north of the gravel area and in adjacent nongravel areas near the pads (Figure 7). The sampling and analyses from these borings will be identical to the first phase.

8.2.1.2 Groundwater Field Screening. During the first phase of groundwater field screening one geoprobe /screened auger boring will be advanced in each gravel pit (PCA-01 and PCA-02). Groundwater samples will be collected at five-foot intervals beginning at the groundwater table and continuing to a maximum depth of approximately 25 feet bgs. The samples will be field screened for BTEX and pesticides by GC and herbicides by immunoassay. Depth to groundwater in the vicinity of the Pesticide Control Shop is anticipated to be 15 feet bgs.

At least 10 percent of the samples will be submitted for laboratory analyses of TCL VOCs, TCL SVOCs, TAL inorganics (nonfiltered and filtered), TSS, herbicides, pesticides, and explosives to verify the field results (Table 2).

If the first phase groundwater field screening suggests groundwater contamination then a second phase will be undertaken. Up to six additional geoprobe/screened auger borings will be advanced to provide upgradient and downgradient groundwater data (PCA-03 through PCA-08). Two boring locations are proposed to be located upgradient north of the gravel areas to provide background data and the remaining four locations are proposed to be south and southeast of the Pesticide Control Shop (Figure 7). These additional investigations will be performed as described in the first phase investigation.

8.2.2 Geotechnical Investigations

The following subsections discuss the rationale and approach of geotechnical investigations proposed for the Pesticide Control Shop. Except for surface water and sediment samples, these investigations will be implemented only if required after the completion of the field screening program.

8.2.2.1 Monitoring Wells/Groundwater Sampling. If required upon completion of the field screening program, up to four water table groundwater monitoring wells (PCG-01 through PCG-04) are proposed to be installed at the Pesticide Control Shop. The final number and location of the wells will be based on the field screening analytical results. The wells will be installed using 6.25-inch HSAs to a

SECTION 8

1 depth estimated to be 25 feet bgs. A soil sample from the well screen interval of
2 each new monitoring well will be submitted for analysis of grain size distribution.
3

4 One round of groundwater samples will be collected from the monitoring wells and
5 analyzed for TCL VOCs, TCL SVOCs, TAL inorganics (nonfiltered and filtered),
6 herbicides, pesticides, explosives, and TSS (Table 2). Concurrent with groundwater
7 sampling, a complete round of groundwater level measurements will be taken from
8 the monitoring wells. In addition, in-situ hydraulic conductivity testing will be
9 performed at the new monitoring wells. Data collected from these tests, when
10 combined with the flow gradients and directions calculated from measured water
11 levels, can be used to estimate groundwater flow directions and velocities in the
12 vicinity of the wells.

13
14 **8.2.2.2 Surface Water/Sediment Investigations.** A surface water/sediment sampling
15 program will be conducted to determine the potential impact that storm water
16 discharge from the Pesticide Control Shop may have on the unnamed brook north
17 of Airfield Road.

18
19 Three surface water/sediment samples will be collected for laboratory analyses
20 (PCD/PCW-01 through PCD/PCW-03). Two samples will be collected from the
21 unnamed brook upstream and downstream of the confluence of the storm water
22 discharge and the unnamed brook (Figure 7). The third sample will be collected at
23 the first depositional area downstream of the storm water discharge. The surface
24 water/sediment samples will be analyzed for TCL VOCs, TCL SVOCs, TAL
25 inorganics (nonfiltered), herbicides, pesticides, explosives, alkalinity/hardness (surface
26 water only), TOC (sediments only), and grain-size analyses (sediments only).

9.0 NEW EGYPT ARMORY (SITE 9)

1 The New Egypt Armory (NEA) Site is located in the northeast corner of the Range
2 Impact Area and is currently used for the maintenance and storage of National
3 Guard vehicles, tanks, and artillery (Figure 2). Two USTs are located in the
4 northwest corner of the site at the head of a steep slope. These USTs are inactive
5 and will be removed in the future. Oil-stained soil was observed around the tanks'
6 fill caps and at the bottom of the slope. A general schematic of the NEA is
7 presented in Figure 9.
8
9

9.1 PREVIOUS INVESTIGATIONS

10 In September 1987, oil-saturated soil was observed around the tanks and at the
11 bottom of the slope. Based on this observation, Dames and Moore (1993) conducted
12 a sampling and analysis program of the NEA Site in 1988. The investigation was
13 part of the Phase I RI program; no additional sampling was conducted during the
14 Phase II RI program. The investigation included soil samples collected from twelve
15 locations at depths of 0 and 2.5 feet bgs, and from three locations at depths of zero,
16 three, and six feet bgs. All soil samples were analyzed for TPH; samples collected
17 from the 3- and 6-foot depths were analyzed for VOCs and SVOCs. Three
18 monitoring wells were installed and sampled during the Phase I RI program.
19 Groundwater samples were analyzed for TPHs, VOCs, and SVOCs.
20
21

22 Results of the soil sampling indicate that generally high levels of TPHs were detected
23 at the NEA Site. TPHs were detected in all 15 soil borings at multiple depths, the
24 maximum occurred at SC-158, located farthest away from the oil tanks
25 (7,112 mg/kg). In general, TPH concentrations decreased with depth; however, they
26 did not decrease with distance from the USTs. In two of the three deep soil borings,
27 acetone was the only organic compound detected. It appears these sample results
28 may reflect oil/grease spillage from parked vehicles in the sampling area rather than
29 contamination from the two USTs.
30
31

32 Soil samples from the monitoring well soil boring log NEA-57 reports a "seam of
33 black (oil?) sand" at a depth of approximately three to four feet bgs. This boring
34 was located near the USTs. The boring logs contain no other observations suggesting
35 leakage from the USTs.
36

SECTION 9

1 Groundwater samples were collected from monitoring wells NEA-57 (background
2 well) NEA-58, and NEA-59. Acetone was detected in well NEA-58 and
3 chloromethane was detected in well NEA-57. No SVOCs or TPHs were detected.
4 According to Dames and Moore (1993), TPH contamination in soil has not migrated
5 to groundwater.

9.2 PROPOSED SCOPE OF WORK

10 Results of previous investigations at this site indicate limited surface and shallow
11 subsurface soil contamination associated with the parking area north of the USTs as
12 well as the potential for subsurface contamination adjacent to the UST. Laboratory
13 analyses of groundwater samples from the existing wells do not suggest substantial
14 groundwater impact although the location of the wells, relative to the groundwater
15 flow direction is not optimum. Given these conditions the objectives of this RI are
16 to:

- 18 1. Assess the nature of the contents of the USTs.
- 19 2. Evaluate the nature and extent of soil contamination adjacent to the
20 USTs to enable appropriate planning for the eventual removal of the
21 USTs.
- 22 3. Evaluate the nature and extent of the surface and shallow subsurface
23 soil impacts associated with the parking area adjacent to the USTs.
- 24 4. Collect and analyze surface water and sediment samples from
25 drainages leading from this site to evaluate the nature and extent of
26 impacts to these media.
- 27 5. Collect and analyze groundwater samples to evaluate the nature and
28 extent of groundwater impacts associated with this site.

31 The proposed scope of work is to be implemented in a phased approach. The first
32 phase will include preparation of a site topographic map, collection of samples from
33 the USTs, conduct of soil field screening work and survey of existing monitoring
34 wells. This will be followed by a second phase which will include installation of up
35 to 5 screened auger/geoprobe borings and up to three additional monitoring wells,
36 if needed and collection and analysis of 13 surface soil samples (3 from drainageways

1 and 10 from the parking area) and 3 surface water/sediment sample pairs. The
2 extent of sampling and analyses to be conducted in the second phase will be
3 dependent on results of the first phase.

4

5 **9.2.1 Site Topographic Base Map**

6 To better evaluate existing conditions at the New Egypt Armory, an accurate base
7 map will be prepared. The map should be prepared before conducting fieldwork at
8 the site to facilitate locating proposed explorations. This map will accurately portray
9 all existing structures at the site including roads, buildings, utilities, fences, water
10 courses, monitoring wells, fuel storage structures, tree lines, drainageways and so
11 forth. In addition, the base map shall include ground surface topography with 2 to
12 5 foot contour intervals. The map shall be presented in hardcopy and CAD
13 compatible computer disk file(s). The map shall use the UTM system for horizontal
14 grid markings. The topographic contours shall be based on NGVD of 1929. This
15 activity should be coordinated with the field checking of existing monitoring wells
16 (see Subsection 9.2.4.1 of this Technical Plan).

17

18 **9.2.2 UST Sampling**

19 To aid in understanding the nature of the two USTs at this site, each UST will be
20 sampled to assess contents. The sampling will estimate the thickness of aqueous and
21 nonaqueous phase liquids as well as gather samples for laboratory analyses of TCL
22 VOCs, TCL SVOCs, TAL inorganics, TPH, herbicides, pesticides and PCBs.
23 Samples will be collected using a disposable, clear Teflon or polyethylene bailer.
24 Thickness of product will be measured using an oil/water interface probe. If pure
25 product is encountered, the only preservation required for the samples is cooling to
26 4°C. This sampling should be conducted prior to initiating soil borings at this site.
27 This may allow for a more focused field screening effort than is currently proposed.
28 In addition, the analyses may assist in evaluating disposal options during the UST
29 removal.

30

31 **9.2.3 Field Screening**

32

33 **9.2.3.1 Soil Field Screening.** The soil field screening program consists of the
34 collection of subsurface soil samples for screening of BTEX, chlorinated solvents
35 (specific field screening analytes will be based on results of UST sample analyses),
36 and TPH. It is anticipated that up to nine soil borings/geoprobe will be utilized in
37 this program.

SECTION 9

1 Five soil borings (NEB-01 through NEB-05) will be advanced around the USTs to
2 assess any leakage associated with the USTs. The borings will be located around the
3 perimeter of the UST and be as close as practicable. Due to the steep break in
4 slope just north of the USTs it may be necessary to off-set one or more of the
5 borings into the parking area adjacent to the USTs. These borings will be advanced
6 with 4.25-inch HSAs to the water table (approximately 55 feet bgs). Soil samples will
7 be collected continuously to 15 feet bgs or the bottom of contamination, whichever
8 is deeper and at five foot intervals thereafter to the bottom of the boring.

9
10 Four soil borings (NEB-06 thorough NEB-09) will be advanced in the parking area
11 to assess the vertical extent of TPH contamination associated with leakage from
12 vehicle parking in this area. Given that the contamination in this area is associated
13 with parked vehicles, these borings will be advanced with 4.25-inch HSAs to the
14 bottom of contamination, estimated to be 10 feet bgs. Soil samples will be collected
15 continuously to the bottom of contamination.

16
17 Soil samples from the nine soil borings will be field screened for BTEX, chlorinated
18 solvents (specific field screening analytes will be based on results of UST sample
19 analyses), and TPH. Soil samples collected at or just above the water table, as well
20 as just above confining layers, will also be submitted for UV screening. At least 10
21 percent of the samples will be submitted for laboratory analyses of TCL VOCs, TCL
22 SVOCs, TAL metals, TOC, and TPH.

23
24 **9.2.3.2 Groundwater Field Screening.** If, following the soil field screening, it appears
25 that groundwater contamination is likely, then up to five screened auger/geoprobe
26 explorations will be conducted. This will provide data for (1) delineating the
27 horizontal and vertical distribution BTEX, chlorinated solvents (specific analytes will
28 be based on UST sample analyses), and TPH in groundwater, and (2) locating
29 additional monitoring wells.

30
31 It is anticipated that up to five screened auger/geoprobe explorations could be
32 needed at the New Egypt Armory (NEA-01 through NEA-05). Locations of the
33 explorations will be dictated by the results of the soil boring program, but it is
34 assumed that these explorations will be situated in two transects near the vicinity of
35 the USTs. Samples will be collected at five foot intervals beginning at the
36 groundwater table and extending to a maximum depth of 85 feet bgs. The samples
37 will be field screened for compounds detected during the soil field screening (BTEX,
38 111TCE, and/or TPH). At least 10 percent of the samples will be submitted for

1 laboratory analyses of TCL VOCs, TCL SVOCs, TAL metals (filtered and
2 nonfiltered metals), TPH, and TSS.

3

4 9.2.4 Geotechnical Investigations

5

6 The following subsections discuss the rationale and approach of geotechnical
7 investigations proposed for the New Egypt Armory. New monitoring well installation
8 and sampling will be conducted only if required after reviewing the results of the soil
9 and/or groundwater field screening efforts.

10

11 **9.2.4.1 Surface Soil Sampling.** To generate adequate data to perform a risk
12 assessment on surface soils at the New Egypt Armory a series of 10 surface soil
13 samples (NES-01 through NES-10) will be collected for laboratory analyses. Because
14 the USTs will be removed from this site, the surface soil sampling will be confined
15 to the parking lot area north of the USTs. Sample locations are approximated on
16 Figure 9. Generally the samples are located in areas where earlier sampling detected
17 TPH. conducted in this area. The samples will be submitted for laboratory analyses
18 of TCL VOCs, TCL SVOCs, TAL metals, TOC, and TPH.

19

20

21 **9.2.4.2 Monitoring Wells/Groundwater Sampling.** Prior to new monitoring well
22 installation, an existing well survey should be performed to confirm site identification,
23 location, and physical integrity. Existing monitoring wells will be checked for label/
24 Site ID and their location as compared to that shown on Figure 9. Sounding depths
25 shall be compared to those presented in Table 2. Monitoring wells that are
26 mislabeled and cannot be accurately located from the field checking shall be
27 resurveyed by a New Jersey licensed land surveyor. Subsection 16.6 addresses the
criteria to be used in determining if monitoring well surveying is needed.

28

29 If required, upon completion of the field screening effort up to three additional
30 monitoring wells (NEG-01 through NEG-03) will be installed at the New Egypt
31 Armory. The final number and location of the wells will be based on the field
32 screening results. The wells would be installed with 6.25-inch HSAs to an estimated
33 depth of 72 feet bgs. Soil samples will be collected at 5 foot intervals during
34 advancement of the soil boring monitoring wells (unless soil samples were collected
35 from an adjacent boring). One soil sample, collected from the well screen interval,
36 will be submitted for analysis of grain size distribution.

37

SECTION 9

1 One round of groundwater samples will be collected from the new and existing
2 monitoring wells (total of six). The samples will be analyzed for TCL VOCs, TCL
3 SVOCs, TAL metals, (filtered and nonfiltered), TSS, and TPH.

4 Concurrent with groundwater sampling, a complete round of groundwater level
5 measurements will be taken from the existing and new monitoring wells. In-situ
6 hydraulic conductivity tests will be performed on new monitoring wells. Data from
7 these test(s), when combined with groundwater level measurements, can be used to
8 estimate groundwater flow directions and velocities in the vicinity of the wells.
9

10 **9.2.4.3 Surface Water/Sediment Investigations.** A surface water/sediment sampling
11 program will be conducted to determine the potential impact to drainageways and
12 streams in the site vicinity. Up to three sediment samples (NED-04 through
13 NED-06) will be collected from the ditches or drainageways leading from the site
14 area. Samples will be collected from areas where sedimentation may occur within
15 the ditches or drainageway. Given the substantial depth to the water table at this
16 site, it is unlikely the surface water will be available for sampling in these ditches/
17 drainageways adjacent to the site. These sediment samples will be submitted for
18 laboratory analyses of TCL VOCs, TCL SVOCs, PCBs, TAL metals, TOC, TPH, and
19 grain size analyses.
20

21 In addition, up to three surface water/sediment sample pairs (NED/NEW-01 through
22 NED/NEW-03) will be collected from the stream located north of the site. These
23 samples will be located such that one sample pair is located upstream from the New
24 Egypt Armory, one sample pair is located in the vicinity of where the drainageway
25 discharges to the stream, and the third sample pair is located approximately 100 to
26 200 feet downstream from New Egypt Armory.
27

28 The surface water/sediment samples will be analyzed for TCL VOCs, TCL SVOCs,
29 PCBs, TAL metals, TOC (sediment only), TPH, TSS (surface water only), alkalinity/
30 hardness (surface water only), and grain size distribution (sediment only).
31

10.0 RANGE LANDFILL (SITE 10)

The Range Landfill is located in the northwestern part of the Range and Impact Area at Ft. Dix and southeast of the former BOMARC site. The Range Landfill is a 21-acre site that has been used for the disposal of waste materials from the Range and Impact Area from 1940 to approximately 1975. Wastes at the site reportedly include rubble, refuse, old storage tanks, and metals. Other wastes may be present because access to the site is not limited by fences or gates. The Range Landfill was considered to be downwind of the BOMARC site when a major fire, at the BOMARC site in 1960, was reported to have released radioisotopes into the atmosphere.

10.1 PREVIOUS INVESTIGATIONS

Two previous investigations have been completed at the Range Landfill by EA and Dames and Moore (EA, 1989; Dames and Moore, 1993). These previous investigations are briefly discussed in chronological order.

EA prepared a PA/SI of potential environmental impacts at Ft. Dix, including the Range Landfill. This investigation consisted of installing, sampling, and analyzing samples from four monitoring wells (RLF-27 through RLF-30). A schematic of the location of these wells is shown in Figure 10. The wells were sampled twice in 1987, and the results from the first round indicated the presence of lead, chromium, and nickel at concentrations up to 15, 1,350 and 6,600 µg/L, respectively, in well RLF-30. The second round of sampling indicated the presence of the same analytes at generally lower concentrations (4.2 µg/L, 14 µg/L, and below detection limit) than detected in the first round in well RLF-27. Additional analytes detected in RLF-27 in the second round included arsenic, cadmium, and copper at concentrations of 29.9, 19.0, and 36.0 respectively.

Dames and Moore, under contract to USATHAMA, conducted an RI of the Range Landfill. The RI consisted of sampling and analysis of RLF-30 in the fall of 1988 and resampling and analysis of RLF-27, RLF-29, and RLF-30. In addition, potable wells FTDX-11 and FTDX-12, approximately 3,000 feet northwest and 3,000 feet southwest of the Range Landfill, respectively, were sampled and analyzed. The groundwater data collected as part of the Dames and Moore RI indicate that groundwater moves toward the northwest. Analysis of collected groundwater samples

SECTION 10

1 indicate that the high concentrations of arsenic, cadmium, copper, chromium, and
2 nickel detected in 1987 have not been detected in subsequent sampling rounds by
3 Dames and Moore as part of the RI, with the exception of 16.59 ppm lead and
4 605 ppm copper in FTDX-12.

5 Based on a field visit to this site on August 18, 1993, the location of the monitoring
6 wells shown on Figure 10 appear suspect. The proposed scope of work will address
7 this issue (see Subsection 10.2.5.1).

10.2 PROPOSED SCOPE OF WORK

13 The reason for the variability in the groundwater analytical results is not clear.
14 Additional work is being proposed to more adequately define and characterize the
15 nature and distribution of potential surficial soil and groundwater contamination at
16 the Range Landfill. In addition, the flow direction of shallow groundwater in the
17 Range Landfill area will be studied and confirmed.

10.2.1 Site Topographic Base Map

21 To better evaluate existing conditions at the Range Landfill and facilitate any
22 remediation/closure of this site, an accurate base map will be prepared. The map
23 should be prepared before conducting field work at the site to facilitate locating
24 proposed explorations. This map will accurately portray all existing structures
25 including roads, buildings, utilities, fences, water courses, monitoring wells, tree lines,
26 and so forth. In addition, the base map shall include ground surface topography with
27 two-foot contour intervals (this may require new photogrammetry). The map shall
28 be presented in hardcopy and CAD compatible computer disk file(s). The map shall
29 use the UTM for horizontal grid markings and shall be prepared at a maximum scale
30 of 1 inch = 100 feet. The topographic contours shall be based on NGVD of 1929.
31 This activity should be coordinated with the field checking of existing monitoring
32 wells (see Subsection 10.2.5.1 of this Technical Plan).

10.2.2 Gross Radiation/Unexploded Ordnance Survey

36 In order to determine if radiation above background levels is present in surface soils
37 and assess the presence of unexploded ordnance (UXO) at this site, a gross radiation
38 and UXO surveys will be completed at the 20 acre Range Landfill. The radiological
39 survey will be conducted to evaluate the exposure hazard to gamma radiation. Gross

1 alpha and beta radiation are not evaluated during such a survey because these types
2 of radiations do not penetrate through soil as far as gamma radiation. Therefore, it
3 is difficult to evaluate the hazards from gross alpha and beta radiation with hand-
4 held instruments.

5 The results of the survey will determine if there are any radioactive sources present
6 in the surface soil that create gamma radiation levels above the background as
7 determined from the measurements of the survey instrument. A detailed procedure
8 for this survey is presented in Section 2.4.10 of the QAPP.

9
10 The UXO survey will be conducted by a qualified UXO subcontractor.
11

12
13 **10.2.3 Geophysics**
14

15 A geophysics program will be completed to determine the approximate fill limits of
16 the Range Landfill. The geophysical survey program will be based on grid transects
17 spaced at approximate 60 foot intervals over an area of approximately 20 acres.
18 Readings will be collected at 20 foot intervals along the transects. See
19 Subsection 16.1 of this Technical Plan and Subsection 2.4.2 of the QAPP for a
20 detailed discussion of the geophysical survey program. The approximate landfill
21 limits will be established using a combination of GPR, EM, and magnetometer
22 surveys. The geophysical survey program will be conducted in a manner which
23 optimizes the delineation of the landfill limits. The EM and magnetometer surveys
24 will be conducted first and the GPR will be utilized to further define anomalous
25 areas. If after conducting the first 10 transects, no evidence of the landfill limits are
26 detected then the program will be reviewed to assess its adequacy. GPR will be
27 useful to determine the limits of filled and disturbed soils as well as potentially
28 characterizing the depth of buried waste. EM will be useful in assessing the potential
29 presence of conductive, nonmetallic wastes. Magnetometry will be useful to establish
30 the location of buried metal objects.

31
32 **10.2.4 Field Screening**
33

34 **10.2.4.1 Groundwater Field Screening.** Up to seven screened auger/geoprobe
35 borings (RLA-01 through RLA-07) will be made at the Range Landfill. One of the
36 screened auger borings will be upgradient and the remaining six will be downgradient
37 (Figure 10). To minimize the possibility of inappropriate boring locations, the
38 monitoring well survey presented in Subsection 10.2.5 of this Technical Plan along
39 with groundwater elevation measurements should be conducted to reassess

SECTION 10

1 groundwater flow direction before proceeding with the boring program downgradient
2 of the Range Landfill. The borings will extend approximately 30 feet below the
3 groundwater table and samples will be collected at 10 foot intervals. Up to three
4 groundwater samples will be collected from each boring for field analysis of BTEX
5 by GC, TSS (laboratory analyses), explosives by immunoassay and alpha/beta/gamma
6 radiation by GM pancake probe and gamma scintillation. These samples will also
7 be submitted for laboratory analyses of TAL metals (filtered and nonfiltered) and
8 TSS as well as being analyzed with a turbidity meter. At least 10 percent of the
9 collected samples will be submitted for confirmatory laboratory analyses. These
10 samples will be analyzed for TCL VOCs, TCL SVOCs, explosives, TSS, and gross
11 alpha, beta, and gamma radiation (Table 2). Results of the field screening will be
12 used to determine the need and most effective location for additional monitoring
13 wells.

10.2.5 Geotechnical Program

10.2.5.1 **Monitoring Wells/Groundwater Sampling.** Prior to new monitoring well
1 installation, an existing well survey should be performed to confirm site identification,
2 location, and physical integrity. Existing monitoring wells shall be checked for their
3 label/Site ID and location as compared to that indicated on Figure 10. Sounding
4 depths shall be compared to those presented in Table 2. Monitoring wells which are
5 mislabeled and cannot be accurately located from the field checking shall be
6 resurveyed by a New Jersey licensed land surveyor. Subsection 16.6 addresses
7 criteria to be used in determining if monitoring well surveying is needed.

Depending on field screening results, up to five additional shallow monitoring wells
(RLG-01 through RLG-05) may be installed with 6.25-inch HSAs at the Range
Landfill. To determine lithology, soil samples will be collected at five foot intervals
as each boring is advanced. A soil sample from the well screen interval of each new
monitoring well will be positioned to intersect the water table. The purpose of
additional monitoring wells will be to further characterize groundwater quality if
groundwater is determined to have been impacted by landfill activities. The new
wells will also be used to further refine groundwater flow directions and conditions
at the Range Landfill.

The new and existing wells will be sampled and analyzed for TCL VOCs, TCL
SVOCs, TAL metals (nonfiltered and filtered), explosives, TSS, and gross alpha, beta,
and gamma radiation (Table 2). In addition, in-situ hydraulic conductivity testing will
be performed on the new monitoring wells. Data collected from these tests, when

SECTION 10

1 combined with the flow gradients and directions calculated from measured water
2 levels, can be used to estimate groundwater flow directions and velocities in the
3 vicinity of the wells.

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1 **11.0 ANC-9 LANDFILL (SITE 11)**

2

3

1 The ANC-9 Landfill is located in the south-central part of the Cantonment Area,
2 southeast of the intersection of Pemberton-Pointville Road and Browns Mills-
3 Lewiston Road (Figure 3). Currently the site is covered with vegetation 30 to
4 40 years old. Linear ground features provide evidence of four trenches 10 to 12 feet
5 apart and 50 to 60 feet long. This site was identified as a possible fill area based on
6 interpretation of aerial photographs dated 1940. However, it should be noted that
7 recent excavations at similar pits/trenches in this area indicates they were used for
8 trench warfare training. Given that many of the trenches at ANC-9 are still apparent
9 at the ground surface, it appears likely that these trenches may have been utilized for
10 training activities and do not reflect past waste disposal practices.

11

12

13 **11.1 PREVIOUS INVESTIGATIONS**

14

15 Three monitoring wells were sampled during the PA/SI program in 1987. Wells
16 WES-3 and AN9-39 were sampled in February 1987, and wells AN9-38 and AN9-39
17 were sampled in April 1987. No organics or explosives were detected in the samples.
18 However, several metals were detected including arsenic, beryllium, cadmium,
19 copper, chromium (total), lead, mercury, and zinc.

20

21 Based on these results, AN9-38 was resampled for dissolved metals and VOCs during
22 the Phase I RI field program. The Phase II RI program included sampling AN9-38,
23 AN9-39, and FTDIX-4 and analyzing for nonfiltered and filtered metals. No
24 contamination was detected in AN9-38 during the Phase I RI investigation, and only
25 elevated levels of iron were detected in AN9-38 and FTDIX-4 during Phase II
26 investigations.

27

28

29 **11.2 PROPOSED SCOPE OF WORK**

30

31 Results of previous investigations at the ANC-9 Landfill indicated a limited potential
32 for groundwater contamination from inorganics. The objectives of the RI at the
33 ANC-9 Landfill are to:

34

35

1. determine if the site is actually a landfill;

SECTION 11

- 1 2. assess the potential risk to human health and the environment
2 associated with contaminants; and
3
4 3. if the data warrants, gather adequate data to support a "No Further
5 Action" decision at this site.
6

7 The proposed scope of work includes a geophysical survey of the area, excavation
8 and sampling of test pits in existing trenches and anomalous areas identified during
9 the geophysical survey, and the analysis of seeps/overland flow channels for surface
10 water drainage. Based on historical information, site reconnaissance, and
11 communications with Ft. Dix personnel, it is believed that the ANC-9 area was
12 utilized as a training area not as a landfill. The geophysical survey and subsequent
13 test pitting (Subsection 11.2.2) will determine if landfill activities have occurred.
14

11.2.1 Geophysical Investigations

17 A geophysical survey of the ANC-9 area will be conducted utilizing a magnetometer
18 and TC to determine the presence and distribution of disposal material. The survey
19 will be conducted over approximately two acres using an approximate 50 foot grid
20 spacing (Figure 11). See Subsection 16.1 of this Technical Plan and Subsection 2.4.2
21 of the QAPP for a detailed discussion of the geophysical survey program.
22 Anomalous areas will be flagged for further investigation. During this survey, the
23 ground surface will be inspected to document the absence of seeps or surface water
24 drainage from ANC-9.
25

11.2.2 Geotechnical Investigations

28 The following subsections discuss the rationale and approach of geotechnical
29 investigations proposed at the ANC-9 Landfill.
30

31 **11.2.2.1 Monitoring Wells/Groundwater Sampling.** An existing monitoring well
32 survey will be performed to confirm site identification, location, and physical
33 integrity. Existing monitoring wells shall be checked for their label/site ID and
34 location as compared to that indicated on Figure 11. Monitoring wells shall also be
35 sounded for water depths and well bottoms. Sounding depths shall be compared to
36 those in Table 2. Monitoring wells that are mislabeled and cannot be accurately
37 located from the field checking shall be resurveyed by a New Jersey-licensed land
38 surveyor. Subsection 16.6 addresses criteria to be used in determining if monitoring
39 well surveying is needed.

1 One round of groundwater samples will be collected from the three existing
2 monitoring wells (WES-3, AN9-38, and AN9-39). Groundwater samples will be
3 analyzed for TCL VOCs, TCL SVOCs, TAL metals (nonfiltered and filtered) TSS,
4 and explosives (Table 2).

5 Concurrent with groundwater sampling, groundwater level measurements will be
6 taken from the existing wells.

7
8 **11.2.2.2 Test Pits.** Up to five test pits (A9S-01 through A9S-05) are proposed to be
9 excavated to investigate existing trenches and anomalous areas identified during the
10 geophysical survey. The test pits will be excavated to a maximum depth of
11 approximately six feet bgs. The test pits will be carefully logged to document the
12 presence or absence of landfilling activities. One soil sample will be collected from
13 each test pit as discrete grab samples. Sample selection will be based on visual
14 observations and PID readings. The samples will be submitted for laboratory
15 analysis of TCL VOCs, TCL SVOCs, and TAL metals, TOC and explosives.
16

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12.0 ANC-2 DISPOSAL AREA (SITE 12)

1 The ANC-2 Disposal Area is located in the northwest Cantonment Area, north of
2 Juliustown Road and west of Bordentown Road (Figure 3). The history of the site
3 area is unknown except that it was a sand and gravel excavation that has been
4 backfilled.

5 12.1 PREVIOUS INVESTIGATIONS

6 Three existing wells were sampled and analyzed in February 1987 during the PA/SI
7 investigation. Groundwater was analyzed for VOCs, SVOCs, total inorganics, and
8 explosives. No organics or explosives were detected, but nickel was detected at
9 70 µg/L in well AN2-40. This well was resampled in April 1987, and results for total
10 inorganics indicate that nickel was not detected above the detection limit of 65 µg/L.
11 Arsenic was also detected at 6 µg/L.

12 The Phase I RI investigation was limited to resampling and analyzing AN2-41 for
13 dissolved metals and recording water level measurements. Phase II water level
14 measurements were conducted in November 1990 and April 1991. Lead was the only
15 contaminant detected during the 1988 sampling of AN2-41. Dames and Moore
16 reported that the arsenic and lead, and the one-time detection of nickel are not
17 contaminants of concern, and could potentially be representative of Ft. Dix area
18 background groundwater concentrations.

19 12.2 PROPOSED SCOPE OF WORK

20 Results of the previous investigation at the ANC-2 Disposal Area indicated limited
21 potential for contamination of the groundwater with inorganic compounds. The
22 objectives of the RI for this site are to:

- 23 1. further define the distribution of contaminants in the groundwater;
- 24 2. address the potential risk to human health and the environment
25 associated with the contaminants;

SECTION 12

1 3. if data warrants, gather adequate data to support a "No Further
2 Action" decision at this site.

3
4 The proposed scope of work includes the field screening of groundwater for
5 inorganics and the potential installation and sampling of groundwater monitoring
6 wells based on field screening results.

7
8 **12.2.1 Site Topographic Base Map**

9
10 To better evaluate existing conditions at the ANC-2 Disposal Area and facilitate any
11 potential remediation/closure of this site, an accurate base map will be prepared.
12 The map should be prepared before conducting fieldwork at the site to facilitate field
13 work at this site. This map will accurately portray all existing structures including
14 roads, buildings, utilities, fences, water courses, monitoring wells, fuel storage
15 structures, tree lines, and so forth. In addition, the base map shall include ground
16 surface topography with two-foot contour intervals (this may require new
17 photogrammetry at this site). The map shall be presented in hardcopy and CAD
18 compatible computer disk file(s). The map shall use the UTM for horizontal grid
19 markings (this map shall be prepared at a 1 inch = 100 feet scale). The topographic
20 contours shall be based on the NGVD of 1929. This activity should be coordinated
21 with the field checking of existing monitoring wells (see Subsection 7.2.4.3 of this
22 Technical Plan).

23
24 **12.2.2 Field Screening**

25
26 Six screened auger/geoprobe borings (A2A-01 through A2A-06) are proposed for the
27 ANC-2 Disposal Area (Figure 12). The objective of the boring investigation is to
28 determine the distribution of inorganic contamination in the groundwater and the
29 need for additional monitoring wells. The borings will be sampled at ten foot
30 intervals starting at the water table and continuing to approximately 30 feet below
31 the water table (approximately four samples per boring). The water table is
32 estimated to be approximately 25 feet bgs. Groundwater samples will be collected
33 and submitted for laboratory analyses of nickel (nonfiltered and filtered) and TSS.
34 Samples will also be qualitatively screened for gross alpha, beta, and gamma
35 radiation using a GM pancake probe and gamma scintillator. At least 10 percent of
36 the samples will be submitted for laboratory analysis for TCL VOCs, TCL SVOCs,
37 TAL metals (nonfiltered and filtered), TSS, TDS, BOD-5, COD, alkalinity, hardness,
38 and gross alpha, beta, and gamma radiation (Table 2).

1 **12.2.3 Geotechnical Investigations**

2
3 The following subsections discuss the rationale and approach of geotechnical
4 investigations proposed for the ANC-2 Disposal Area.

5
6 **12.2.3.1 Monitoring Wells/Groundwater Sampling.** Prior to new monitoring well
7 installation, an existing well survey will be performed to confirm site identification,
8 location, and physical integrity. Existing monitoring wells shall be checked for their
9 label/site ID and location as compared to that indicated on Figure 12. Monitoring
10 wells shall also be sounded for water depths and well bottoms. Sounding depths shall
11 be compared to those in Table 2. Monitoring wells that are mislabeled and cannot
12 be accurately located from the field checking shall be resurveyed by a New Jersey-
13 licensed land surveyor. Subsection 16.6 addresses criteria to be used in determining
14 if a monitoring well survey is needed.

15
16 Up to four new monitoring wells (A2G-01 through A2G-04) are proposed to be
17 installed, contingent on field screening results indicating contamination. One
18 monitoring well will be installed in an upgradient location, and the remaining three
19 will be installed downgradient of the ANC-2 Disposal Area. The number and
20 location of the wells will be based on field screening analytical results and existing
21 well locations. The monitoring wells will be installed using 6.25-inch HSAs and
22 screened at the water table. Groundwater is estimated to be approximately 25 feet
23 bgs. A soil sample from the well screen interval of each new monitoring well will be
24 submitted for analysis of grain size distribution.

25
26 One round of groundwater samples will be collected from the three existing
27 monitoring wells and four (proposed) new monitoring wells. Groundwater samples
28 will be analyzed for TCL VOCs, TCL SVOCs, TAL metals (nonfiltered and filtered)
29 TSS, TDS, BOD-5, COD, alkalinity, hardness, and gross alpha, beta and gamma
30 radiation (Table 2).

31
32 Concurrent with groundwater sampling, groundwater level measurements will be
33 taken from new and existing wells. In addition, in-situ hydraulic conductivity testing
34 will be performed at the existing and new monitoring wells. Data collected from
35 these tests, when combined with the flow gradients and directions calculated from
36 measured water levels, will be used to estimate groundwater flow velocities in the
37 vicinity of the wells.

SECTION 12

1 **12.2.3.2 Surface Water/Sediment Investigations.** A surface water/sediment sampling
2 program will be performed to determine the potential impact that the ANC-2
3 Disposal Area may have on Bakers Brook.

4 Three surface water/sediment samples (A2D/A2W-01 through A2D/A2W-03) will
5 be collected for laboratory analysis from Bakers Brook, located north of the ANC-2
6 Disposal Area (Figure 12). One sample will be collected from an upstream location
7 and one sample will be collected from a downstream location relative to the landfill.
8 The third sample will be collected from a location on Bakers Brook approximately
9 adjacent to the landfill. The surface water/sediment samples will be analyzed for
10 TCL VOCs, TCL SVOCs, TAL metals, TOC (sediment only), alkalinity/hardness
11 (surface water only), PCBs, and grain-size analyses (sediment only).

1 **13.0 BOILER BLOWDOWN AREA (SITE 13)**

2

3

4 The Boiler Blowdown Area is located approximately one-third mile east of the Ft.
5 Dix Boiler Plant Building 5426, in the northeast Cantonment Area (Figure 3). Boiler
6 blowdown was discharged to the storm sewer until about 1979; since then it has been
7 discharged to the sanitary sewer. On occasion, blowdown enters the sanitary sewer
8 at such high pressure and temperature that a discharge is released to a swale located
9 adjacent to a stream that flows from Willow Pond.

10

11 **13.1 PREVIOUS INVESTIGATIONS**

12

13 One shallow soil sample was collected at the Boiler Blowdown Area during the
14 PA/SI conducted at Ft. Dix. No organic contaminants were detected; however, lead
15 was detected at concentrations up to 100 mg/kg. Other detected metals included
16 arsenic, chromium, copper, nickel, selenium, silver, and zinc. Based on the results
17 of the PA/SI, the Phase I RI program (Dames and Moore, 1991) consisted of the
18 collection of three shallow soil samples (Figure 13). The samples were collected
19 from the surface soil (0 to 6 inches) at low points in the swale and analyzed for the
20 presence of metals. No additional sampling was conducted during the Phase II RI
21 program.

22 Results of the soil sampling show detected levels of arsenic, barium, chromium,
23 copper, lead, nickel, selenium, silver, thallium, and zinc in samples taken from the
24 swale. Lead was detected in SC-156 at 142 mg/kg, and thallium was detected in two
25 samples, SC-154 and SC-155 at 23 mg/kg and 22.8 mg/kg, respectively. Lead
26 concentrations were within the typical background range for the eastern United
27 States.

28 During the Environmental Investigation at Fort Dix two sites, the 4300 and 4400
29 Motor Pools, located adjacent to the Boiler Blowdown Area were investigated (ICF,
30 1994). These investigations included sampling and analyses of the surface water and
31 sediment from the stream discharge associated with Willow Pond as well as
32 subsurface soil and groundwater sampling. A series of six monitoring wells, three
33 geoprobe soil explorations, six SCAPS probes, and three soil borings have been
34 conducted in this area. Approximate locations of these explorations are presented
35 on Figure 13.

SECTION 13

1 The analyses of inorganics conducted on select samples from these explorations has
2 not detected the presence of thallium. The results of these explorations will be
3 incorporated into the RI report for this site including the presentation of geologic
4 cross sections.

5

6

7 **13.2 PROPOSED SCOPE OF WORK**

8

9 Results of previous investigations at this site indicate isolated presence of thallium
10 in surface soil samples. The scope of work included in this effort is intended to
11 assess if these detects represent isolated occurrences of thallium or if elevated
12 thallium is common in this drainage way. Results from ongoing work at the 4300 and
13 4400 motor pools, adjacent to the site, will be incorporated into the RI report
14 presentation this site.

15

16 **13.2.1 Geotechnical Investigations**

17

18 The following subsections discuss the rationale and approach of geotechnical
19 investigations proposed for the Boiler Blowdown Area.

20

21 **13.2.1.1 Surface Soil Sampling.** To assess whether the existing site data reflects
22 isolated occurrences of thallium or a more widespread elevated condition, series of
23 11 surface soil samples (BBS-01 through BBS-11) will be collected from surface soils
24 on the stream bank adjacent to the drainageway. The approximate sample locations
25 are presented on Figure 13. One sample will be collected upstream from the SC-
26 155/SC-156 sample location near the storm drain discharge point, the second sample
27 will be collocated with the SC-155/SC-156 samples to confirm the concentration of
28 thallium in the soils, the third sample will be collected on the south bank of the
29 drainage way opposite from the SC-155/CS-156 sample location, and the remaining
30 eight samples will be collected from a grid centered over the SC-155/SC-156 sample,
31 spaced at approximately 50 foot intervals.

32

33 These samples will be submitted for laboratory analyses of TCL VOCs, TCL SVOCs,
34 and TAL metals.

35

36 **13.2.1.2 Surface Water/Sediment Investigations.** A surface water/sediment sampling
37 program will be conducted to assess the presence of elevated levels of thallium in
38 surface water and sediment downstream from Willow Pond. The three surface
39 water/sediment sample pairs (BBB/BBW-01 through BBB/BBW-03) will be

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1 collected from the stream. These samples will be located such that one sample pair
2 is located upstream from the location of the outfall of the storm sewer , likely near
3 the discharge point of Willow Pond, west of Texas Avenue. The second surface
4 water/sediment sample pair will be located in the drainageway adjacent to the SC-
5 155 and SC-156 surface soil sample locations. The third sample pair will be located
6 approximately 200 feet downstream from the second sample pair.

7 The surface water and sediment samples will be submitted for laboratory analyses of
8 TCL VOCs, TCL SVOCs, TAL metals, TOC (sediment only), alkalinity/hardness
9 (surface water only), PCBs, and grain size distribution (sediment only).

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14.0 AREA NORTH OF DOGWOOD LAKE (SITE 14)

1 The Area North of Dogwood Lake is located in the northwestern Cantonment Area
2 (Figure 3), and is currently an open field. Record drawings obtained from Ft. Dix
3 dated 1917 indicate that 19 buildings, a water tank, railroad tracks, and three USTs
4 previously existed at the site. The buildings included clothing stores, offices, a
5 garage, and several storage sheds. A 1945 drawing indicates that the site was also
6 used as a troop billeting area and contained 17 two-story, barracks-style buildings.
7 The buildings were removed in the early 1960s (Dames and Moore, 1993).

14.1 PREVIOUS INVESTIGATIONS

12 Contamination was first discovered at this site in 1980 when the USAEHA installed
13 well MW-17 as part of the study conducted to determine groundwater flow patterns
14 at Ft. Dix. A groundwater sample collected from MW-17 indicated a petroleum-
15 based compound at a concentration of approximately 2,000 µg/L (USAEHA, 1984).

17 The purpose of a 1984 investigation by the USAEHA was to locate the source and
18 extent of potential groundwater contaminated by organic compounds in and around
19 the Area North of Dogwood Lake (USAEHA, 1984). This 1984 USAEHA
20 investigation included a geophysical survey as well as the drilling, installation, and
21 sampling of 32 test wells. Samples were collected and analyzed for TPHs and
22 xylenes. The results indicated TPH concentrations that ranged from 100 to
23 247,000 µg/L, forming a contaminant plume approximately 500 feet long by 200 feet
24 wide at the site. Xylene concentrations in the groundwater ranged from 10 to
25 3,500 µg/L and formed a contaminant plume with a center about 50 feet
26 downgradient of the center of the TPH plume. The study recommended additional
27 investigations to locate the buried fuel tanks and determine the extent of petroleum
28 hydrocarbon contamination at greater depth.

30 IKW (IKW, 1985) conducted another investigation at this site in 1985. Eleven soil
31 borings were drilled to depths of 20 to 30 feet. Soil samples collected from the
32 borings were analyzed for TPH. Concentrations of TPH ranged from less than 300
33 to 37,000 µg/L. The highest concentrations were generally detected in samples
34 collected at a depth of 4 to 6 feet below the water table. The investigation
35 concluded that the source of petroleum contamination was an old spill or leakage of
36 petroleum products. The remaining hydrocarbon contaminants were believed to be

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1 firmly adhered to the soil, while mobile fractions appeared to have been flushed from
2 the area by groundwater and surface water. The study recommended the installation
3 of one monitoring well to be monitored at least once every six months.

4 In 1986, EA conducted a geophysical survey using TC over the Area North of
5 Dogwood Lake. The purpose of the survey was to locate possible buried metal tanks
6 (USTs) for excavation. The surveyed area boundaries were Maryland Avenue, the
7 north shore of Dogwood Lake, Pennsylvania Avenue, and Airfield Road (EA, 1986).
8 Several buried pipelines, areas of buried scrap metal, and sections of railroad tracks
9 were detected during the survey. No USTs were located as a result of the survey.
10 It is assumed that the USTs were excavated and removed, or that the 1917 drawings
11 were inaccurate in depicting the number and/or location of USTs.

12 Dames and Moore conducted an RI in 1988 and 1991. Investigations performed
13 included a soil gas survey, surface water/sediment sampling, soil borings, and
14 installation/sampling of groundwater monitoring wells.

15 Soil gas samples were collected at 66 locations at the Area North of Dogwood Lake.
16 These samples were analyzed for methyl tertiary butyl ether and BTEX to evaluate
17 the presence of petroleum products. BTEX was detected in samples collected near
18 monitoring wells NDL-78 and NDL-79 on the north shore of Dogwood Lake. Fifteen
19 soil samples were collected at depths of 0 to 10 feet from two well borings (NDL-78
20 and NDL-79) and three soil borings (SC-252 through SC-254), and analyzed for
21 VOCs and TPH (see Figure 7). TPHs were detected in soil samples from NDL-78
22 at concentrations up to 503 mg/kg. No contamination was detected in soil samples
23 from the other borings.

24 Six groundwater monitoring wells were installed by Dames and Moore between 1988
25 and 1990: NDL-60 through NDL-63 and NDL-78 and NDL-79 (see Figure 7).
26 Groundwater samples were collected from the six wells and analyzed for VOCs and
27 TPH. TPHs were detected in groundwater at NDL-78 at a concentration of
28 2,450 µg/L. Petroleum-related compounds were not detected in any other
29 groundwater samples.

30 Three surface water/sediment samples were collected from Dogwood Lake
31 (Figure 7). These samples were analyzed for VOCs and TPH. TPHs were detected
32 at SE-117, SE-118, and SE-119 at 81.89, 50.84, and 79.10 mg/kg, respectively, below
33 regulatory standards. No contaminants were detected in the surface water samples.

1 Widespread TPH contamination was detected in soils and groundwater in 1984 and
2 1985. In 1988 and 1990, groundwater, soil, and soil gas sampling indicated elevated
3 TPH concentrations near NDL-78, suggesting that some migration of the previously
4 detected contaminant plume has occurred (Dames and Moore, 1993).

5

6

7 **14.2 PROPOSED SCOPE OF WORK**

8

9 Results of previous investigations at the Area North of Dogwood Lake indicate
10 contamination of soil and groundwater by weathered fuel compounds. Contaminant
11 distribution last identified in 1990 indicates groundwater contamination along the
12 north shore of Dogwood Lake in the vicinity of monitoring well NDL-78.

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14 The objectives of the RI for this site are to:

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1. further assess the distribution of groundwater, surface water, and sediment contamination; and
2. assess the potential risk to human health and the environment associated with the contamination.

The proposed scope of work will be implemented in a phased approach. Groundwater field screening will be used to assess groundwater contamination and identify the need for, and location of, additional monitoring wells. Surface water and sediment data from samples collected by ICF Kaiser Engineers (1993) along the north shore of Dogwood Lake will be evaluated for fuel-related compound contamination. The proposed scope of work is presented in the following subsections in more detail.

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14.2.1 Field Screening

Geoprobe/screened auger sampling of groundwater and field screening for BTEX and TPH will be performed at the Area North of Dogwood Lake. Geoprobe/screened auger sampling and field screening will provide data for: (1) delineation of the horizontal and vertical distribution of BTEX in groundwater, and (2) placement of new monitoring wells.

It is anticipated that up to 3 transects of geoprobe/screened auger borings, with a total of 18 borings may be completed (Figure 7). It is anticipated that up to 3

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1 groundwater samples will be collected from each boring: at the water table, and at
2 5 and 10 feet below the water table. These sampling depths are subject to change
3 based upon the maximum attainable exploration depth and depth to groundwater.
4 The maximum depth of borings is anticipated to be 25 feet bgs. Depth to
5 groundwater is anticipated to be between 5 and 15 feet bgs.

6 The first transect includes a series of 8 borings (DLA-01 through DLA-08),
7 distributed uniformly in the shaded area shown in Figure 7. The location of this
8 transect was chosen based on the most recent groundwater data, which indicates that
9 the only detects of fuel-related compounds were found in monitoring well NDL-78
10 (Dames and Moore, 1993). Subsequent transects, and the location of borings within
11 transects, will depend on the analytical results of the first transect. The second
12 transect will be located north of the first and will include up to 7 borings (DLA-09
13 through DLA-15). The third transect will be located north of the second transect
14 and trending northwest/southeast and will include up to 3 borings (DLA-16 through
15 DLA-18). The purpose of the third transect is to investigate groundwater quality in
16 the area of TPH contamination identified by USAEHA in 1984 (USAEHA, 1984).
17 The sequence of these transects is subject to change based on field screening results.
18

19 Groundwater samples from these explorations will be analyzed in the field for BTEX
20 by GC, and for TPH by IR. At least 10 percent of the samples will be submitted for
21 confirmatory laboratory analysis of TCL VOCs, TCL SVOCs, TAL metals
22 (nonfiltered and filtered), TSS, and TPH (Table 2).

24 14.2.2 Geotechnical Investigations

25 The following subsections discuss the rationale and approach of geotechnical
26 investigations proposed for the Area North of Dogwood Lake.

27 **14.2.2.1 Monitoring Wells/Groundwater Sampling.** Prior to new monitoring well
28 installation, an existing monitoring well survey will be performed to confirm Site ID,
29 location, and physical integrity. Specifically, each well shall be sounded for water
30 level and well depth; this data will be checked against existing logs and depths
31 presented on Table 2. Wells that cannot be accurately located shall be resurveyed
32 by a licensed New Jersey land surveyor. Subsection 16.6 addresses criteria to be used
33 in determining if a monitoring well survey is needed. In addition, water levels will
34 be measured from all existing wells, including PTS-22, to evaluate groundwater flow
35 direction prior to field screening activities.
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Up to 4 new groundwater monitoring wells (DLG-01 through DLG-04) will be installed at the Area North of Dogwood Lake. The objective of these well installations is to provide future monitoring points for groundwater contamination that may be identified during the groundwater field screening activities. The number and location of wells will be based on field screening analytical results and existing well locations. To enhance evaluation of potential free product, new monitoring well borings will have continuous soil samples collected from approximately 10 feet above the water table to five feet below the water table. These soil samples will be field screened for BTEX and TPH. Soil samples collected at or just above the water table, as well as just above confining layers, will also be submitted for UV screening. At least 10 percent of the field screening soil samples will be submitted for confirmatory laboratory analysis. The confirmatory samples will be analyzed by the analytical laboratory for TCL VOCs, TCL SVOCs, TAL metals, and TPH.

These water table wells will be installed using HSAs. New monitoring well screens will be installed to span the water table. A soil sample for the well screen interval of each new monitoring well will be submitted for analysis of grain size distribution.

One round of groundwater samples will be collected from the six existing monitoring wells (including PTS-22) and 4 (proposed) new monitoring wells. Groundwater samples will be analyzed for TCL VOCs, TCL SVOCs, TAL metals (nonfiltered and filtered), TSS, and TPH (Table 2). During groundwater sampling, a complete round of groundwater level measurements will be taken from all new and existing wells. In addition, a surface water level measurement will be obtained from a staff gauge to be installed in Dogwood Lake.

In-situ hydraulic conductivity testing (slug testing) will be conducted at the site on all newly installed wells to establish the in-situ hydraulic conductivity of the aquifer. Data collected from these tests, when combined with groundwater flow gradients and directions calculated from measured water levels, can be used to estimate groundwater flow velocities. Slug testing procedures are discussed in Section 16.0.

14.2.2.2 Surface Water/Sediment Investigations. As part of an EI/AA being conducted by ICF-Kaiser Engineers for the USAEC, three surface water/sediment samples were collected in 1993 from the north shore of Dogwood Lake. At the time of preparation of this Technical Plan, the Site IDs for these samples are unknown, but will be available in the EI Report being prepared by ICF-Kaiser Engineers. These samples were analyzed for TCL VOCs, TCL SVOCs, TAL metals, TOC (sediment only) and grain-size analyses. To complement the ICF-Kaiser Engineers

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1 data, two additional surface water/sediment samples (DLD/DLW-01 and
2 DLD/DLW-02) will be collected from the northwest corner of Dogwood Lake
3 (Figure 7). These samples will be analyzed for TCL VOCs, TCL SVOCs, TAL
4 metals, TPH, alkalinity/hardness (surface water only), PCBs, TOC (sediment only)
5 and grain-size analyses (sediments only). Data from these surface water/sediment
6 samples will be used to evaluate the potential impact to Dogwood Lake from the
7 identified groundwater contaminant plume in the area north of the lake.
8

9 One staff gauge, designated DLSTAFF1, will be installed in Dogwood Lake to
10 measure the surface water level. Measurements from this gauge will provide data
11 for assessment of hydrologic and hydrogeologic interaction.

1 **15.0 GOLF COURSE PESTICIDE MIXING AND STORAGE AREA (SITE 15)**

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4 The Golf Course Pesticide Mixing and Storage Area (Site 15) is located in the
5 northern portion of the Cantonment Area within the Site 4 - Golf Course Leaking
6 Tank Area (Figure 3). Site 15 includes Building 3150 - the Pesticide Storage
7 Building, and Building 3151 - the Golf Course Herbicide Storage Building. Also,
8 part of Site 15 is the pesticide mixing area located east of Building 3150 and
9 southeast of Building 3151 (Figure 6). Historical practices and operations at the site
10 are unknown; however, pesticide mixing operations reportedly occurred at the site
11 as recently as 1985.

12 **15.1 PREVIOUS INVESTIGATIONS**

13 Several previous investigations have been conducted at the Golf Course Pesticide
14 Mixing and Storage Area. These investigations are discussed below in chronological
15 order.

16 The USAEHA conducted a study at Ft. Dix in 1975 to evaluate distribution of
17 pesticides in selected media at Ft. Dix. The sites tested in 1975 included the Golf
18 Course Area. Chlordane was detected in soil at the Golf Course at a concentration
19 of 34.2 mg/kg. The study recommended review and revision of pesticide application
20 procedures at Ft. Dix (USAEHA, 1978).

21 The USAEHA conducted another study in 1985 to identify pesticide residues
22 associated with the Pest Management Program at Ft. Dix. The investigation was
23 initiated as a result of concern that past use and disposal of pesticides at Ft. Dix
24 might have resulted in pesticide residue accumulation in the environment in excess
25 of amounts expected from normal use.

26 The investigation included the collection and analysis of soil and sediment samples
27 within and around the Pesticide Control Shop (Building 5352), the Old Pesticide
28 Storage Shop (Building 5317), and the Golf Course Herbicide Storage
29 (Building 3151).

30 According to the report, data from years of monitoring by the USAEHA as well as
31 other data from the National Pesticide Monitoring Program have shown that, as a
32 general guideline, conditions at a site should be of concern when the total residual

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pesticide concentration in the soil equals or exceeds 5 mg/kg. In accordance with such a guideline, residual pesticide concentration detected in the Pesticide Control Shop in 1985 was of concern. The maximum total pesticide residue concentration detected in samples at the Golf Course Herbicide Storage Building Area was 5.41 mg/kg.

The study recommended further evaluation of the health and environmental hazards associated with pesticide management at Ft. Dix, especially with pesticide storage, mixing, and handling procedures.

EA, under contract to USATHAMA, prepared a PA/SI of environmental conditions at Ft. Dix (1989). This study was conducted in the adjacent Golf Course Leaking Tank Area (Site 4) as discussed in Section 5.0. No organics were detected in groundwater samples from monitoring well GLF-15 and pesticides were not detected in samples from wells GLF-15, GLF-16, or GLF-17 (Figure 6).

Dames and Moore, under contract to USATHAMA, conducted an RI at the Golf Course Pesticide Storage and Mixing Area (Dames and Moore, 1993). The investigation was conducted in two phases:

- Phase I involved collection and analysis of 3 surface soil samples SC151 through SC153.
- Phase II involved collection and analysis of soil samples from 3 borings (SC249 through SC251) each drilled to a depth of 10 feet bgs.

The locations of these sampling points are shown on Figure 6. Pesticides were detected only in soil sample SC-153, at a total concentration of approximately 1 ppm. SVOCs were detected in borings SC249 through 251 up to total concentration of 14 ppm.

15.2 PROPOSED SCOPE OF WORK

Results of previous investigations at the Golf Course Pesticide Storage and Mixing Area indicate limited soil contamination by pesticides, and some subsurface soil contamination by SVOCs that may not be related to pesticide storage and mixing activities.

1 The objectives of the RI for this site are to:

2

3 1. further define the extent of surface soil, subsurface soil, groundwater,
4 surface water and sediment contamination by pesticides and herbicides;

5

6 2. assess the risk to human health and the environment associated with
7 contamination; and

8

9 3. provide adequate data for assessment of remedial alternatives.

10

11 In addition to the field investigations described in the following subsections, existing
12 data will be reassessed in light of revised Maximum Contaminant Levels (MCLs) and
13 NJDEP soil cleanup criteria (last revised 2/3/94).

14

15 **15.2.1 Geotechnical Investigations**

16

17 The following subsections discuss the rationale and approach of geotechnical
18 investigations proposed for the Golf Course Pesticide Mixing and Storage Area.

19

20 **15.2.1.1 Surface Soil.** The soil sampling program is summarized in Table 3. A grid
21 pattern will be established at the identified pesticide mixing area (see Figure 6) for
22 collection of twelve surface soil samples (GPS-01 through GPS-12). Soil samples will
23 be collected in unpaved areas. These samples will be submitted for laboratory
24 analyses of TCL VOCs, TCL SVOCs, TAL inorganics, pesticides, herbicides, and
25 TOC. The analytical results from these samples will be used to determine
26 contaminant distribution in surface soils as a result of post activities at the pesticide
27 mixing area.

28

29 **15.2.1.2 Soil Borings.** Two soil borings (GPB-01 and GPB-02) will be drilled within
30 the identified boundary of the former pesticide mixing area (Figure 6). The soil
31 sampling program is summarized in Table 3. The borings will be drilled with
32 4.25-inch HSAs, and soil samples will be collected continuously from ground surface
33 to the first significant fine-grained unit beneath the water table, estimated to be 30
34 feet bgs.

35

36 These soil samples will be field screened for selected pesticides and BTEX by GC
37 and herbicides by immunoassay. Soil samples collected at or just above the water
38 table, as well as just above confining layers, will also be submitted for UV screening.

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1 At least 10 percent of the field screening samples will be submitted for confirmatory
2 laboratory analysis. The confirmatory samples will be analyzed by the analytical
3 laboratory for TCL VOCs, TCL SVOCs, TAL inorganics, pesticides, herbicides, and
4 TOC.

5
6 **15.2.1.3 Monitoring Wells/Groundwater Sampling.** Groundwater sampling,
7 conducted for the Golf Course Pesticide Mixing and Storage Area, is addressed in
8 Subsection 5.2.3.1 of this Technical Plan.
9

10
11 **15.2.1.4 Surface Water/Sediment.** Surface water/sediment samples will be collected
12 to assess impact to these media from pesticide mixing and storage. The surface
13 water/sediment sampling program is summarized in Table 4.
14

15 Nine surface water/sediment samples (GTD/GTW-01 through GTD/GTW-09) will
16 be collected from the nearby stream and ponds for analysis. These samples will be
17 collected as part of Site 4 Golf Course Leaking Tank Area investigation and are
18 discussed in Subsection 5.2.3.3 of this plan, and shown on Figure 6. The three
19 samples to be collected upstream of the site are intended to provide data for
20 delineation of site related affects, particularly for herbicides and pesticides in the
21 Golf Course Area. This will allow an assessment of the impact from the pesticide
22 mixing and storage area to the sediment/surface water in the immediate site vicinity.
23

24 Up to two additional surface water/sediment sample pairs (GPD/GPW-01 and
25 GPD/GPW-02) will be collected from any observed surface drainageways from the
26 identified former pesticide mixing area. It is anticipated that surface water may not
27 be available for sampling at these locations. These sediment samples will be
28 submitted for laboratory analyses of TCL VOCs, TCL SVOCs, TAL inorganics,
29 pesticides, herbicides, TOC (sediment samples only), alkalinity/hardness (surface
water only), PCBs, and grain size analyses (sediment only) (see Table 4).

1 **16.0 TECHNICAL APPROACH FOR FIELD OPERATIONS**

2
3
4 The objective of this task is to establish the nature and distribution of contamination
5 at the 13 Sites at Ft. Dix identified in the USAEC task order. Data collected will be
6 used to evaluate and recommend alternatives for site remediation and to produce
7 final decision documents regarding remedial action at the site.

8
9
10 The field investigations will include soil borings and test pits to characterize
11 contaminant distribution and the geologic setting; a field analytical program (using
12 Geoprobe, screened augers and soil borings) to further characterize contaminant
13 distribution; monitoring well and piezometer installation and sampling to more
14 accurately characterize groundwater quality and hydrogeologic parameters; surficial
15 geophysical surveys; surface and subsurface water and sediment sampling; surface soil
16 sampling; and surveying of sampling locations.

17
18 Field sampling results will be used to characterize each site and further identify
19 environmental contaminants, contaminant distribution, and contaminant migration
20 pathways. The results will also be used in the risk assessment to determine the
21 impact of the detected contaminants on human and ecological receptors, as well as
22 in the FS to evaluate remedial alternatives.

23
24 The following subsections describe the elements of the proposed field program in the
25 general order to be completed.

26 **16.1 GEOPHYSICAL SURVEY**

27
28 Geophysical surveys will be conducted using GPR, magnetometer, and TC at several
29 sites to characterize the extent of landfill waste. GPR will also be used to clear
30 locations where intrusive (subsurface) sampling techniques will be used.

31 **16.1.1 GPR Survey Procedures**

32
33 Before conducting the GPR survey, a grid system will be established to reference the
34 survey results. The survey will then be conducted using a GSSI SIR System III GPR
35 unit equipped with a 200 or 500 megahertz antenna. The survey will consist of a
36 nonintrusive walkover along the established transects with the GPR antenna. The
37 survey results will be printed in the field on a strip chart recorder for interpretation

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1 by a qualified geophysicist. This interpretation may redirect the survey transects to
2 optimize the data generated during the survey.

3
4 Subsection 2.4.2.2 of the QAPP presents a more detailed discussion of the theory
5 behind the GPR technique in addition to more specific procedures for conducting the
6 survey and interpreting the results.

7
8 **16.1.2 Magnetometer Survey Procedures**

9
10 A magnetometer survey will be used to locate buried steel containers and define
11 boundaries of pits or trenches with ferrous debris. The survey consists of a
12 nonintrusive walkover and will be conducted utilizing a magnetic gradiometer
13 consisting of a pair of total field magnetic sensors mounted on a survey pole. Data
14 will be collected at pre-established grid nodes within the survey area, which will be
15 marked in the field prior to the survey with wire-stake flagging. The data will be
16 interpreted and anomalies marked in the field. This interpretation will be used to
17 locate intrusive investigations.

18
19 Subsection 2.4.2.1 of the QAPP presents a more detailed discussion of the theory
20 behind the magnetometer technique in addition to more specific procedures for
21 conducting the survey and interpreting the data.

22
23 **16.1.3 Terrain Conductivity Survey Procedures**

24
25 A TC survey will be performed to complement the magnetometer survey and will be
26 used to help map landfill boundaries and potential contaminant plumes in
27 groundwater. The survey consists of a nonintrusive walkover and will be conducted
28 utilizing a transmitter and receiver which produces and measures a magnetic field.
29 Data will be collected continuously along survey lines established within the survey
30 area prior to the survey. The data will be interpreted and anomalies marked in the
31 field. This interpretation will be used to locate intrusive investigations.

32
33 Subsection 2.4.2.3 of the QAPP presents a more detailed discussion of the theory
34 behind the terrain conductivity technique in addition to more specific procedures for
35 conducting the survey and interpreting the data.

16.2 SOIL SAMPLING PROGRAM

The objectives of the soil sampling program are to characterize the geologic setting at each site and characterize the nature and distribution of contamination. Table 3 summarizes the soil exploration location rationale and analytical sampling for each site.

16.2.1 Soil Sampling

The characterization of the subsurface soils encountered at each site will be accomplished by careful logging and sampling of soils. A geologist will be present during drilling and soil sample collection activities to maintain descriptive logs and collect appropriate samples for chemical and physical analyses. Subsurface soil borings will be advanced using 4.25-inch HSAs, and soil samples will be collected with a 3-inch outside diameter (OD) split-spoon sampler. The sampler will be advanced using the standard penetration test technique (see Section 2.5.1 of the QAPP for a detailed description). Samples will be screened in the field using a PID for contaminant concentration and sample prioritization.

Analytical soil samples will be packed in appropriate sample bottles using a clean stainless steel spatula, and placed in a cooler maintained at 4 degrees Centigrade (°C). During the sampling phase, the VOC samples will be collected first and will be transferred such that air space is minimized in the sample bottle. Samples collected for SVOCs, metals, TOC, and TPH analyses will be homogenized using the "Coning and Quartering method".¹ Each sample bottle will contain a sample label, which will include the project number, sample number, analysis to be performed, time, date, and sampler's initials. Phthalate free gloves will be used during sampling activities and will be changed between each sample location. Soil sampling points will be located to map accuracy at the time of sample collection and locations will be marked or staked for future reference.

¹Coning and Quartering Method: Non-VOA samples should be homogenized using the following procedure: First remove rocks, twigs, leaves, and other debris, if they are not considered part of the sample. Then the soil/sediment should be removed from the sampling equipment and placed in a decontaminated stainless steel pan. The sample is then thoroughly mixed using a decontaminated stainless steel spoon. The soil/sediment in the pan should be scraped from the sides, corners, and bottom of the pan, rolled to the middle of the pan, and initially mixed. The sample should then be quartered and moved to the four corners of the pan. Each quarter of the pan should be mixed individually, and then rolled to the center of the container and the entire sample mixed again.

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1 Geotechnical laboratory physical analysis of soil samples will be conducted on ten
2 percent soil samples collected from each site where soil borings and monitoring wells
3 are completed. The ten percent of samples will be calculated based on standard five-
4 foot interval sampling. Each soil sample will be analyzed for moisture content
5 (American Standards and Test Methods [ASTM] D 2216), grain-size distribution
6 (ASTM D 422), and Atterberg limits (ASTM D 4318). Samples will be assigned a
7 symbol and description.

8 The selection of soil samples for physical testing will be made by the geologist.
9 Testing results will be used to assist in describing the subsurface soils, to verify the
10 geologist field logs, and to develop site-specific values for soil porosity and
11 hydrogeologic properties of the soils. Soil samples collected for physical testing will
12 be placed in glass jars, labeled according to boring number and depth, and shipped
13 to a geotechnical laboratory.

14 **16.2.1.1 Surface Soil Sampling.** Soil samples will be collected to determine the
15 nature and extent of near-surface contamination. Surface soil samples will be
16 collected from 0 to 6 inches bgs using a trowel, hand auger, tulip bulb planter, or
17 stainless steel spoon and placed in a stainless steel bowl. After collection of the
18 VOC sample, the remaining sample will be homogenized utilizing the coning and
19 quartering technique. The soil samples will be placed in pre-labeled sample jars and
20 sent for laboratory analysis. Remaining samples will be discarded into the 55-gallon
21 Department of Transportation (DOT)-approved drums being used for collection of
22 cuttings. Appropriate sample containers are described in Subsection 5.2 of the
23 QAPP.

24 In the event it is necessary to remove asphalt to collect the sample, a pickaxe or
25 jackhammer may be used. All sampling and asphalt-removal equipment will be
26 decontaminated between sample collections as described in Subsections 16.5.1 and
27 16.5.3 of this Technical Plan.

28 **16.2.1.2 Natural Gamma and EM Conductivity Borehole Logging.** Natural gamma
29 and EM conductivity borehole logging survey will be completed in several of the
30 exploratory soil borings. The logging tools will be run the entire length of the
31 borehole to assist in defining the geologic setting within the regional stratigraphic
32 framework.

1 After logging is complete, the geologist will compare the log to other existing logs
2 in conjunction with lithologic data. Subsection 2.4.2.4 of the QAPP describes how
3 the gamma and EM conductivity logging will be completed.

4

5 **16.2.2 Borehole Advancement**

6

7 Drilling of soil borings at each site will proceed as follows:

8

- 9 a. Boring/well drilling permits and regulations, as required by the
10 NJDEP, will be secured and/or complied with, and clearance of
11 underground utilities will be arranged with appropriate plant personnel
12 and local utility companies.
- 13 b. Water used for auger and drilling equipment decontamination will be
14 obtained from the Ft. Dix water supply source and tested prior to use.
- 15 c. Filter pack material and bentonite to be used in the drilling program
16 will be approved by USAEC as specified in Subsection 2.4.4 of the
17 QAPP.
- 18 d. Sampling and drilling will be performed under direct supervision of the
19 assigned geologist.

20

21 Soil samples for chemical analysis will be collected using a decontaminated
22 split-spoon sampler. A truck-mounted HSA or mud-rotary drilling rig will be used
23 to drill the overburden soil borings. Subsection 2.4.5 of the QAPP describes the
24 techniques for advancing the boreholes using both the HSA and mud-rotary
25 technique. As the boreholes are advanced, split-spoon samples will be collected at
26 the intervals specified in Tables 2 and 3 of this Technical Plan. Details of the
27 monitoring well installation are provided in Subsection 16.3.6 of this Technical Plan.

28

29

30 **16.2.3 Borehole Logging**

31

32 During drilling of the soil borings, the geologist will describe activities in the field
33 boring logs. Upon completion of each boring or monitoring well, information from
34 the boring logs will be transferred to Field Drilling or Well Construction File forms,
35 and original boring logs will be submitted to USAEC as soon as possible following
36 completion of the boring or well. The following data will be recorded in the boring
37 logs, in real-time, at the drill site:

38

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- 1 a. Depths in feet and fractions thereof (tenths of feet). Measurements
2 will be entered on the data entry forms.
- 3 b. Soil descriptions, in accordance with the USCS and prepared in the
4 field by the geologist, which include the following information:
5
 - 6 • Classification
 - 7 • USCS symbol
 - 8 • Secondary components and estimated percentage
 - 9 • Color (using Munsell Soil Color Chart)
 - 10 • Plasticity
 - 11 • Consistency (cohesive soil) or density (noncohesive soil)
 - 12 • Moisture content
 - 13 • Texture/fabric/bedding
 - 14 • Depositional environment
- 15 c. Cutting descriptions, including basic classification, secondary
16 components, and other apparent parameters
- 17 d. Visual estimates of secondary soil constituents (if terms such as "trace,"
18 "some," or "several" are used, their quantitative meanings will be
19 characterized in a general legend).
- 20 e. Length of sample recovered for each sample interval for driven (split-
21 spoon) samples.
- 22 f. Blow counts, hammer weight, and length of fall for split-spoon samples.
- 23 g. Estimated interval for each sample.
- 24 h. Depth to water first encountered during drilling and the method of
25 determination (any distinct water-bearing zones below the first zone
26 also will be noted).
- 27 i. General description of the drilling equipment used, including the rod
28 size, bit type, pump type, rig manufacturer, model, and drilling
29 personnel.
- 30 j. Drilling sequence.

- 1 k. Unusual problems.
- 2
- 3 l. Start and completion dates of all borings, and a chronological
- 4 time-sequence of all events.
- 5
- 6 m. Lithologic boundaries.
- 7

8 **16.2.4 Borehole Abandonment**

9

10 Once the completion depth for the soil borings has been reached and samples have
11 been collected, the shallow borings (i.e., those less than 25 feet deep) will be
12 backfilled with material removed from the hole in accordance with the NJDEP
13 Sealing Requirements². These shallow borings will be completed at the surface with
14 topsoil, concrete, or asphalt material to level with the ground surface immediately
15 adjacent to the borehole. Deep borings (those greater than 25 feet deep) will be
16 abandoned by tremie grouting with a cement bentonite grout mixture to within
17 one-foot of the ground surface. The last foot will be completed with topsoil, concrete
18 or asphalt level with the ground surface immediately adjacent to the borehole. For
19 deep soil borings (greater than 25 feet deep) and monitoring well borings, soil
20 cuttings will be visually inspected and checked with a PID for contaminants and
21 containerized in 55-gallon DOT-approved drums. These drums will be managed as
22 discussed in Subsection 16.5.

23

24 **16.2.5 Test Pits**

25

26 Test pits will be excavated at several sites to better characterize the nature of the
27 media and character of the shallow subsurface soils. The precise locations of the pits
28 will be established in the field at each site based on aerial photographs, GPR results,
29 and soil boring data. Test pits will be excavated to a maximum depth of 10 feet bgs
30 at each site.

31

32 Logging of test pit soils will be consistent with the protocols presented in
33 Subsection 16.2.3. In addition, photographs will be taken to record subsurface
34 conditions encountered. Soil samples will be collected from each test pit for

35 ²According to NJDEPE procedures for drilling and sealing boring/probe holes, borings less than
36 25 feet in depth, regardless of whether the boring has reached the water table, may be sealed by
37 backfilling. Borings exceeding 25 feet must be tremie grouted.

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1 chemical analyses as listed in Table 3 of this Technical Plan. Samples will be
2 selected based on PID readings and field observations.

3 Each test pit will be backfilled with the soil excavated from that pit. During
4 excavation, the upper one to two feet of soil will be segregated from deeper soils.
5 The upper soil will be replaced at the ground surface when backfilling the excavation.
6 Decontamination of soil sampling and test pitting equipment as well as residuals
7 management is specified in Subsection 16.5 of this Technical Plan.
8

10 11 12 13 14 15 16 17 18 19 20 16.3 HYDROGEOLOGIC INVESTIGATION

21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 Hydrogeologic investigations will be conducted at several of the subject sites. The investigation at each of the sites will consist of either screened auger or geoprobe sampling and field screening, and/or monitoring well installations and sampling. The screened auger/geoprobe sampling and field screening component is intended to quickly and accurately characterize the extent of groundwater contamination while giving a good approximation of contaminant concentrations. This will provide focused monitoring well installations to better characterize the contaminant concentrations in the groundwater flow system at each site.

16.3.1 Screened Auger Sampling

The screened auger program will be completed to characterize the lateral and vertical and horizontal distribution of the groundwater contaminants. Table 2 summarizes the screened auger programs. Screened auger borings will be completed in a series of transects extending downgradient from the site.

Initial screened auger borings will have more frequent sampling (approximately five samples per boring). A minimum of three groundwater samples will be collected from each screened auger boring. Depths from which samples will be collected will be based on the analytical results from existing monitoring wells, the geologic data from the three soil borings, and previously installed screened auger borings.

Screened auger soil borings will be advanced using a 4.25-inch ID HSAs equipped with O-rings and a five-foot slotted lead auger. If necessary, the slotted auger section may be placed after the lead auger. The slotted auger shall be constructed with either laser-slotted openings or welded wire-wound well screen. In either case, the slot size shall not exceed 0.010 inches.

1 Borehole advancement will be similar to a typical HSA soil boring, although the
2 cutter head of the auger will be equipped with a bottom plate; and therefore, no
3 center plug will be needed. Given this arrangement, no soil samples will be
4 collected.

5 Upon reaching the specified sampling interval, a pump apparatus including a
6 decontaminated submersible pump, a packer assembly and associated tubing, and
7 electrical wiring will be lowered into the borehole annulus and positioned at or below
8 the screened auger section. The packer assembly will contain materials such as
9 polyethylene and/or Teflon, which are known not to interfere with the determination
10 of organic constituents. The packer will be situated above the pump to isolate the
11 screened auger from the remainder of the auger flights.

12 After positioning the pump apparatus, the pump will be turned on to begin purging
13 the casing. As the water level begins to fall in the borehole, the packer will be
14 inflated to isolate the screened auger interval. Purging will continue until three to
15 five volumes of the packered zone have been removed from the boring. Field
16 parameters (pH, specific conductance, temperature, dissolved oxygen, and turbidity)
17 will be monitored during the purging. If recovery is poor, it may be necessary to
18 abandon the packer assembly and purge the annulus dry. In this case, it may not be
19 possible to purge three to five screened auger volumes.

20 After purging is complete, groundwater samples will be collected from the pump
21 outlet. In this case, the discharge rate will be reduced approximately 100 ml/minute
22 to avoid unnecessary agitation of the sample water. Or, if the packer assembly is not
23 utilized, the sampling will be completed with a bailer.

24 Decontamination procedures and residuals management for the screened auger
25 borings are discussed in Subsection 16.5.

31 16.3.2 Groundwater Sample Collection with Geoprobe

32 The Geoprobe system will be used to collect groundwater field screening samples to
33 assess horizontal and vertical distribution of contaminants in groundwater.

34 Groundwater field screening samples will be collected using the Geoprobe in the
35 following manner:

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1 A stainless steel water sample probe (either slotted or retractable) is placed
2 on the end of a 1-inch diameter threaded rod and pushed or hammered to the
3 required sampling depth (i.e., into the water table). The slotted probe is used
4 to collect a water table sample, the retractable probe is used when sampling
5 a discrete interval within the water bearing zone. The retractable probe will
6 be pushed or hammered to the desired sampling depth within the saturated
7 zone. When the desired depth is achieved, the point is retracted and opened
8 to the groundwater. The groundwater samples are collected using a small
9 diameter (Teflon or stainless steel) bailer, polyethylene tubing equipped with
10 a check valve, or peristatic pump.

16.3.3 Monitoring/Piezometer Well Drilling

14 Monitoring well borings will be drilled with a 6.25-inch ID (10-inch OD) HSA with
15 a retractable center plug. Subsection 2.4.5 of the QAPP presents a more detailed
16 discussion of the HSA drilling technique. If excessive soil heaving is encountered in
17 the intermediate or deep monitoring well borings, the boring may be drilled with the
18 mud-rotary technique. Soil samples for lithologic characterization will be collected
19 using a split-spoon sampler at five-foot intervals.

20 Lithologic samples will be described according to the procedures outlined in
21 Subsection 16.2.3. A geotechnical sample from each borehole will be analyzed for
22 grain size at a qualified geotechnical laboratory.

25 Piezometers to be completed for instrumenting of an aquifer test will be drilled with
26 4.25-inch ID HSAs. The screen interval will be positioned to intercept granular soil
27 units. Subsection 2.4.7 of the QAPP presents additional details on piezometer
28 construction.

30 Soil cuttings from every HSA monitoring well/piezometer boring will be
31 containerized in 55-gallon DOT-approved drums, labeled, dated, and stored on-site
32 at Ft. Dix. Disposition of containerized soil cuttings will be carried out in accordance
33 with NJDEP and USAEC requirements.

35 When mud-rotary drilling methods are used to drill deep monitoring wells, the
36 drilling fluid used in this process will consist of approved bentonite (see
37 Subsection 2.4.4 of the QAPP for approval requirements) and approved source water.

1 The bentonite/water drilling fluid will promote borehole stability in the
2 unconsolidated formations, control the problem of heaving sands typically
3 encountered in these formations, and will allow for downhole sampling.
4 Subsection 2.4.5 of the QAPP presents a more detailed discussion of mud-rotary
5 drilling techniques.

6
7 Mud that circulates to the surface during drilling operations will be containerized in
8 the steel mud pit. Cuttings that settle out during drilling and all drilling fluid
9 removed from the boring will be containerized in 55-gallon DOT-approved drums,
10 labeled, dated, and stored on-site at Ft. Dix. Disposition of containerized cuttings
11 and drilling fluid will be carried out by Ft. Dix in accordance with NJDEP and
12 USAEC requirements.

13
14 If a monitoring well is to be installed that fully penetrates a confining layer, the well
15 will be double-cased to prevent the vertical migration of contaminants during drilling.
16 The borehole will be installed utilizing a telescoping casing method advanced by the
17 mud-rotary drilling technique. The boring will be advanced to the confining layer
18 using 12-inch diameter mud-rotary drilling. An 8-inch inside diameter black steel
19 casing will be permanently installed to inhibit vertical migration of contaminants.
20 The boring will be continued to the desired depth below the confining layer using
21 8-inch outside diameter mud-rotary drilling. The drilling fluid will be changed after
22 the setting of the permanent casing to prevent cross-contamination.

23
24 **16.3.3.1 Natural Gamma and EM Conductivity Logging.** A natural gamma and EM
25 conductivity borehole logging survey will be completed in several monitoring well
26 borings. The gamma logging tool will be run the entire length of the monitoring well
27 boring prior to setting the monitoring well, to better position the monitoring well
28 screen to assist in defining the location of the geologic setting within the regional
29 stratigraphic framework.

30
31 When natural gamma logging a double-cased boring, a two-phased logging technique
32 will be used to maximize the effectiveness of the logging. The first phase will occur
33 prior to the setting of the upper permanent casing. The second phase will occur after
34 the completion of the remaining portion of the boring but prior to the installation
35 of the monitoring well.

36
37 The geologist will compare the gamma log to other existing logs in conjunction with
38 lithologic data, and select the depth for the screened interval. Subsection 2.4.2.4 of
39 the QAPP describes in detail how the gamma logging will be conducted.

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16.3.4 Monitoring Well Abandonment

In the event that a well must be abandoned, procedures outlined in the USAEC geotechnical requirements will be followed. Once approval from USAEC is obtained, the boring in question will be abandoned by tremie grouting from the bottom of the boring to ground surface and a completed well abandonment form (DWR-020) will be submitted to the NJDEP.

16.3.5 Groundwater Monitoring Well Design and Construction

Upon completion of monitoring well borings, the monitoring well will be constructed in the borehole annulus. After the well is placed in the boring, sand filter pack and borehole sealing materials will be placed around the well as the drill casing is withdrawn. Subsection 2.4.6 of the QAPP provides additional details regarding monitoring well design and construction.

The following materials will be used in well construction:

- a. Monitoring wells - flush-threaded polyvinyl chloride (PVC) Schedule 40 casing with 4-inch ID. No PVC solvents or glues will be used. The well screen will be factory slotted, with a slot width of 0.010 inch. Screens will be 10 feet long.
- b. Grout, composed (by weight) of 20 parts Portland cement (type II or V) up to one part bentonite with a maximum of 8 gallons of approved source water per 94-pound bag of cement. Bentonite will be added after mixing the cement and water.
- c. Commercially available bentonite pellets designed for well-sealing purposes, or in the case of the intermediate and deep wells, a thick bentonite slurry. Subsection 2.4.4 of the QAPP outlines the requirements of bentonite approval.
- d. Sand material, used in the filter pack around the well screen, compatible with both the screen slot size and aquifer materials. Subsection 2.4.4 of the QAPP outlines the requirements for filter pack approval.

1 e. A six-inch protective steel casing installed over the top of the PVC
2 riser. This will include a padlocked cap, which will prevent entry of
3 water but will not be airtight. A ¼-inch diameter weep-hole will be
4 installed, above the level of the internal mortar collar. Four steel
5 cement filled pickets will be installed around each monitoring well/
6 piezometer. The protective casing and each picket shall be painted
7 orange. A cement collar shall be placed around each monitoring well/
8 piezometer. Cement collars shall be sloped to permit runoff of water
9 away from the well. Well designations including the NJDEP well
10 permit numbers and Ft. Dix site identifications will be engraved and
11 stenciled on the protective casing. No aerosol spray paints will be
12 used.

13
14 Locks used to secure the monitoring wells will be brass and keyed alike. In addition,
15 existing monitoring wells utilized in this RI/FS will have existing locks replaced with
16 the same keyed alike brass lock.

17
18 If shallow monitoring wells are screened at a shallow water table, modifications to
19 the USAEC geotechnical requirements may be necessary. Because of the anticipated
20 shallow water table (5 to 10 feet below surface), and the required length of the filter
21 pack overlap (at least 5 feet above the screen), the required length of the bentonite
22 seal (5 feet) may be shortened so that the screened interval spans the water table.
23 This modification will be made only after obtaining approval by the USAEC Project
24 Geologist and Contracting Officer's Representative (COR).

25
26 **16.3.6 Groundwater Monitoring Well Installation Procedures**

27
28 When a monitoring well boring is completed, the geologist will visually inspect the
29 hole. Plumbness will be obtained by careful leveling of the drill rig prior to the
30 commencement of drilling. Well installations will begin within 48 hours of boring
31 completion, and, if possible, will continue uninterrupted until completed.

32
33 The well screen will be carefully steam-cleaned and rinsed with source water before
34 being installed in the hole. All well screens will have a solid bottom. Solid casing
35 will extend from the screen to approximately 2.5 feet above ground surface.

36
37 After the monitoring well screen and casing have been placed in the borehole, filter
38 pack material will be gradually placed around the well screen as the drill casing is
39 slowly withdrawn. The top of the filter pack will be periodically sounded to assess

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1 the location of the filter pack within the borehole annulus. Upon completion, the
2 filter pack material will extend to approximately five-feet above the top of the well
3 screen.

4 In monitoring wells with less than 10 feet of water above the top of the filter pack,
5 a five-foot thick bentonite pellet seal will be installed to isolate the well screen.
6 Bentonite seals will not be less than two feet thick, if possible. Bentonite seals less
7 than two feet thick will be necessary only in monitoring wells screened within five-
8 feet of the ground surface. Bentonite pellet seals will be allowed to hydrate for a
9 minimum of one hour before cement-bentonite grout is added to the borehole
10 annulus.

11 In monitoring wells having more than 10-feet of water above the filter pack, a 10-foot
12 thick bentonite slurry seal will be tremie pumped above the filter pack. In both
13 instances (pellet or slurry seal) the drill casing will be slowly withdrawn as the seals
14 are placed.

15 Above the bentonite seals a cement-bentonite grout will be tremie-pumped to within
16 one-foot of the ground surface. Tremie pumping will ensure that all grouts and
17 slurry seals do not contain voids. The grouting will be a continuous process
18 conducted under the guidance of the geologist (see Subsection 2.4.6.2 of QAPP for
19 additional details).

20 A six-inch diameter aboveground steel protective casing will be sealed in the cement
21 concrete surface cover to secure the well against tampering. This casing will extend
22 approximately 2.5 feet above ground surface and will be seated 2.5 feet into the well
23 seal grout. After the grout seal has set (approximately 24 hours), it will be checked
24 for settlement, and additional grout (of approved composition) will be added to fill
25 any depressions. Protective posts will be installed around the aboveground finished
26 well to prevent damage to the wells by vehicles.

27 A monitoring well construction diagram will be prepared for each monitoring well.
28 This diagram will indicate the bottom of the boring, screen location, filter pack
29 location, bentonite seals, cement-bentonite grout, height of riser above ground
30 surface, and protective casing detail. The actual composition of the grout, seals, and
31 granular backfill will also be recorded.

16.3.7 Monitoring Well Development

Development of groundwater monitoring wells will be recorded and submitted to the COR within three working days following completion. The following data will be recorded on Well Development-Field Data Records as specified in the geotechnical requirements:

- a. Well designation;
- b. Date of well installation;
- c. Date of development;
- d. Static water level before and 24 hours after development;
- e. Quantity of water lost during drilling and fluid purging, if water is used;
- f. Quantity of standing water in well and annulus (30 percent porosity assumed for calculation) prior to development;
- g. Specific conductivity, temperature, and pH measurements taken and recorded at the start of development, twice during, and at the conclusion of development;
- h. Depth from top of well casing to bottom of well;
- i. Screen length;
- j. Depth from top of well casing to top of sediment inside well, before and after development;
- k. Physical character of removed water, including changes during development in clarity, color, particulates, and odor;
- l. Type and size/capacity of pump and/or bailer used;
- m. Description of surge technique, if used;

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- 1 n. Height of well casing above or below ground surface; and
- 2
- 3 o. Quantity of water removed and removal time.

5 Wells will be developed by pumping the groundwater with an electric-powered
6 submersible, positive displacement, or centrifugal pump until the water is clear and
7 the well is sediment free to the fullest extent practical. If well yields cannot sustain
8 the flow rate of the submersible pump, a bailer will be used to evacuate the well.
9 Water will not be added to the well to aid in development, nor will any type of
10 air-lift technique be used.

11 Well development will begin no sooner than 48 consecutive hours after completion
12 of the mortar collar placement, but not longer than seven days. Development will
13 proceed until the following conditions are met:

- 14 a. The well water is clear to the unaided eye;
- 15
- 16 b. Parameters including pH, conductivity, and temperature have
17 stabilized;
- 18
- 19 c. The sediment thickness remaining in the well is less than five percent
20 of the screen length;
- 21
- 22 d. At least five well volumes (including the saturated filter material in the
23 annulus) plus the volume of water added during the drilling process
24 have been removed from the well; and
- 25
- 26 e. The cap and all internal components of the well casing above the
27 water table have been rinsed with well water to remove all traces of
28 soil/sediment/cuttings. Washing will also be conducted before and/or
29 during development.
- 30

31 If standard well development conditions cannot be met, the COR and USAEC
32 Project Geologist will be contacted for guidance.

33 Decontamination of downhole development equipment and management of
34 development water are addressed in Subsection 16.5.

16.3.8 Monitoring Well Sampling

Groundwater samples will be collected from new and existing monitoring wells. Table 2 lists well designations and analyses to be conducted. The following procedures will be followed on the day of sampling:

- a. The depth to water will be measured accurate to 0.01 foot and total depth of the well will be measured accurate to 0.1 foot. Both measurements will be made from the top of the PVC casing. The water column height in the well will be calculated. Each monitoring well will be checked for the presence and thickness of immiscible phase liquids.
- b. Sampling equipment will be placed on polyethylene sheeting to prevent contact with soil. Phthalate free gloves will be worn by all samplers to prevent possible contamination of the sample.
- c. Five times the amount of water in the well casing and saturated filter pack annulus will be evacuated with a submersible pump attached to dedicated polyethylene tubing, or Teflon bailer. In the event of low-yielding wells and subsequent low recovery rates (due to the presence of fine-grained sediments), a decision to reduce the well purging to less than five volumes may be made. This decision will be subject to approval by the COR. The amount of water actually purged will be measured and recorded.
- d. Conductivity, pH, and temperature will be measured at the start, during, and at the end of the well purging. These data will be forwarded to the COR at the completion of all sampling activities. Calibration standards on the pH, conductivity, and temperature meters will be run and recorded prior to and after each day of sampling.
- e. Sampling will be accomplished using a bailer constructed of inert materials (Teflon or stainless steel) attached to a Teflon-coated stainless steel or polypropylene monofilament leader approximately five-feet long. Disposable nylon rope attached to this leader will not come into contact with the water. No glue will be used in the construction of these bailers.

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1 To minimize adsorption of analytes on the PVC surface of the well
2 casing, which could affect the apparent groundwater concentration of
3 certain contaminants, each well will be sampled within three hours of
4 purging (well recovery permitting).

5

6 f. Sample containers will be filled in order of decreasing analyte
7 volatility. However, metal or inorganic samples may be filled first to
8 minimize sample turbidity. Metal samples will be collected as both
9 nonfiltered and filtered samples.

10

11 g. Purge water will be containerized, labeled, dated, and stored on-site
12 for proper disposal. Based on the analysis of groundwater samples
13 collected from the monitoring wells, the containerized purge water will
14 likely be disposed at the Ft. Dix wastewater treatment plant.

15

16 Decontamination of sampling equipment and management of purge water will be
17 conducted in accordance with Subsections 16.5.1, 16.5.2, and 16.5.4.

18

19 To ensure the effectiveness of decontamination procedures, periodic equipment rinse
20 blanks will be taken by pouring analyte-free water over or through equipment after
21 cleaning, collecting the rinsate, and submitting it for chemical analysis (see
22 Subsection 5.4.1 for QA/QC sample schedule).

23

24 Pertinent information collected during purging and sampling activities will be
25 recorded in Groundwater-Field Data Records. The following data will be collected
26 if applicable: well number; date; time; static water level; depth of well; calculation
27 of the five volume equivalent; number of bailers; pumping rate; time of pumping;
28 drawn-down water level; on-site water quality measurements; fractions sampled and
29 preservatives; weather conditions and/or miscellaneous observations; and signature
30 of sampler and date.

31

32 Each sample will be carefully labeled so that it can be identified by laboratory
33 personnel (see Subsection 17.1 of this Technical Plan for the sample identification
34 system). The sample label will include the installation code, sample number,
35 analytes/analysis requested, preservation/filtering information, time, date, and
36 sampler's initials. All samples will be identified by completing, in non-water-soluble
37 ink, a standard preprinted label at the time of collection. Information concerning
38 preservation methods, matrix, and sample locations will be included on Analytical
39 Request Forms to accompany the samples to the laboratory. Samples will be

1 maintained at 4°C from time of sample collection until analysis. The analytical
2 parameter coverage for the groundwater samples is presented in Subsection 17.3.4
3 of this Technical Plan. Sample preservation methods and filtering methods for
4 metals samples are described in detail in Subsections 5.3 and 2.5.2, respectively of
5 the QAPP.

6

7 **16.3.9 Water Level Measurements**

8

9 Water level measurements at existing and newly installed groundwater monitoring
10 wells will be obtained using an electric water level sounding device. Using a
11 calibrated sounder, this procedure is accurate to 0.01 foot. The tape will be rinsed
12 with water from the approved source, cloth-wiped, and allowed to air dry between
13 consecutive water level measurements. Measurements of the depth to groundwater
14 will be referenced to a permanently marked reference point on the monitoring wells
15 (highest point on the top rim of the PVC casing). To aid in documenting the
16 presence or absence of nonaqueous phase liquid, monitoring wells will also be
17 checked for the presence and thickness of immiscible phase liquids.

18

19 **16.3.10 Aquifer Testing**

20

21 **16.3.10.1 In-Situ Hydraulic Conductivity Testing.** Aquifer testing will be conducted
22 to establish the in-situ hydraulic conductivity of the shallow aquifer. Data collected
23 from these tests, when combined with the flow gradients and directions calculated
24 from measured water levels, can be used to estimate groundwater flow velocities in
25 the vicinity of the wells. These aquifer characteristics are important for evaluating
26 the potential for contaminant migration. The method of Bouwer and Rice³ will be
27 used to evaluate slug test data.

28 The proposed rising-head test consists of lowering a cylindrical slug into the well
29 below the water table and waiting for the water level to stabilize. The slug is then
30 raised above the water table and the rate at which the water rises and stabilizes in
31 the well is recorded. The test procedure for each well will be as follows (alternate
32 procedures are presented in Section 2.4.9.2 of the QAPP):

33

- 34 • Record an initial static water level in the well.

35

36 ³Bouwer, H., and R.C. Rice, 1976. A slug test for determining hydraulic conductivity of unconfined
37 aquifers with completely or partially penetrating wells. Vol. 12, No. 3, pp 423-428.

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- 1 • Connect the Hermit data logger to a pressure transducer and place the
- 2 transducer in the well, below the water table.
- 3
- 4 • Insert the slug below the water level and allow the water level to
- 5 stabilize.
- 6
- 7 • Record stabilized water level on data logger.
- 8
- 9 • Remove the slug as rapidly as possible in an effort to obtain an
- 10 instantaneous fall in water level.
- 11
- 12 • Record water level recovery until the water reaches a level equal to at
- 13 least 98 percent of the initial static water level or for a maximum of
- 14 two hours of recovery.

If a minimal response in water level occurs as a result of the removal of the slug, drawdown required for the rising-head test will be produced by pumping the well. If this occurs, the test procedure will be as follows:

- 19 • Record an initial static water level in the well.
- 20
- 21 • Lower a 2-foot submersible pump with PVC tubing and electrical
- 22 wiring into the well.
- 23
- 24 • Connect Hermit data logger to a pressure transducer and place the
- 25 transducer in the well, below the water table.
- 26
- 27 • Allow water level to stabilize.
- 28
- 29 • Record stabilized water level on data logger.
- 30
- 31 • Run pump until approximately five-feet of drawdown occurs.
- 32
- 33 • Record water level recovery until the water reaches a level equal to at
- 34 least 98 percent of the initial static water level or for a maximum of
- 35 two hours of recovery.
- 36
- 37

1 To minimize the potential for cross-contamination, all down-hole equipment
2 including pressure transducers and slugs will be decontaminated according to the
3 procedures outlined in Subsection 16.5.

4
5 **16.3.10.2 Aquifer Tests.** Aquifer tests will provide the hydrogeologic data required
6 to develop remedial alternatives at sites as well as data to calibrate/validate the
7 numerical groundwater flow model. Specific aquifer tests to be conducted will
8 include step-drawdown and constant-discharge tests.
9

10 Aquifer testing will be monitored by a computerized data logging instrument and
11 pressure transducers. Portable field printers and a laptop computer should be used
12 to facilitate data collection and analysis during the tests. The following is a general
13 overview of the aquifer tests to be conducted.
14

15 A step-drawdown test will be conducted at a well to establish well efficiency, specific
16 capacity, and short-term well yields. Three extraction rates will be conducted for
17 successive three-hour durations. A constant discharge test will be conducted at the
18 well to calculate transmissivity, storage coefficients, aquifer parameters, and
19 long-term pumping rates.
20

21 A storage tank and a portable granular activated carbon canister will be used to store
22 and treat water before direct discharge or transport to the on-base treatment system.
23
24

25 **16.4 SURFACE WATER/SEDIMENT ASSESSMENT PROGRAM**

26
27 A surface water/sediment sampling program will be conducted at several sites to
28 obtain a preliminary indication of contaminant impacts to these environments. The
29 intention of these programs is to generate adequate data to assess whether further
30 studies on the ecological communities are warranted, and if so, what type of studies
31 should be conducted.
32

33 **16.4.1 Surface Water and Sediment Sampling Procedures**

34
35 At each sampling location, the surface water sample will be collected first to avoid
36 unnecessary disturbance of the water column. Chemical analyses will be the same
37 for the sediment and water samples collected from the same location to aid in
38 comparison and evaluation. Surface water and sediment sampling will be conducted
39 in accordance with USEPA Region II and NJDEP guidance.

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1 **16.4.1.1 Surface Water Sampling.** Surface water sampling will be conducted in
2 accordance with procedures outlined in Subsection 2.5.2.1 of the QAPP. Briefly, the
3 sampler will wade out into the stream or brook, if sampling from the shore cannot
4 be performed and the water column is clear enough to see underwater objects. The
5 sampling location will be approached from the downstream direction, without
6 entraining additional sediment into the surface water sample. The bottle will be
7 held upside down, immersed several inches below the water and then turned upright
8 to fill. The bottle will then be removed from the water, field measurements will be
9 made (pH, conductivity, temperature), the proper preservative (if required) will be
10 added, and the bottle will be capped, labeled, and placed in a cooler. Alternately,
11 a long-handled dip sampler may be used where access to the sampling location is
12 difficult or contact with water is not permitted by the Health and Safety Plan.

13
14 If multiple surface water samples are to be collected from a flowing stream, samples
15 will be obtained from the furthest point downstream, moving upstream as the
16 sampling progresses. Surface water sampling locations will be marked on a site map.
17 A numbered stake will be placed above the visible high water mark on the bank
18 closest to the sampling location. A description of the sampling site will be entered
19 into the Surface Water Sediment-Field Sampling Record. This description will be
20 adequate to allow the sampling station to be relocated at some future date.

21
22 **16.4.1.2 Sediment Sampling.** Sediment samples will be collected from the bottom
23 of surface water bodies to evaluate the impacts of the various study sites on the
24 sediment of these surface water bodies and drainage courses. Sediment sampling
25 locations will coincide with surface water sampling locations. Because areas of
26 greatest contamination occur in depositional areas in aquatic systems, depositional
27 areas within the surface water bodies being investigated will be targeted for sampling
28 locations. Sediment samples will be analyzed for TOC in addition to specified
29 chemical parameters.

30
31 Sediment sampling will be conducted in accordance with Subsection 2.5.2.2 of the
32 QAPP. Samples will be collected with stainless steel spoons or trowels if there is
33 little or no water on top of the sediment at the particular sampling location. If the
34 water velocity is low at sampling locations where the water above the sediment is a
35 few feet deep or the water velocity is high, a stainless-steel corer or other device that
36 eliminates sample washing will be used.

37
38 Sediment samples collected for all analyses except VOCs will be thoroughly mixed
39 before being placed in sample containers. Rocks, twigs, and other debris will be

1 removed from the sample prior to homogenization if they are not considered part of
2 the sample. Samples for VOCs analyses will be collected as individual grab samples
3 and will not be homogenized. The procedure for homogenization of samples
4 (referred to as coning and quartering) is described below.

5 Following removal of rocks, twigs, leaves, and other debris, the sediment is removed
6 from the sampling device and placed in a stainless-steel pan, then thoroughly mixed
7 using a stainless steel spoon. The sediment in the pan is scraped from the sides,
8 corners, and bottom of the pan, rolled to the middle of the pan, and initially mixed.
9 The sample is then quartered and moved to the four quarters of the pan. Each
10 quarter of the sample is mixed individually, and then rolled to the center of the
11 container, and the entire sample is mixed again. Then, the appropriate amount of
12 sample is delivered to the sample jar with the trowel or spoon. A description of
13 sediment properties (i.e., color, texture, odor, organic content, grain size) is recorded
14 in the Surface Water/Sediment-Field Sampling Record immediately after sample
15 collection.

16 Sediment sample locations will be marked on a site map. A numbered stake will be
17 placed above the visible high water mark on the bank closest to the sampling
18 location. A description of the sampling site will be entered into the field logbook to
19 allow the sampling station to be reoccupied at a future date.

20 **16.4.1.3 Staff Gauges.** Staff gauges will be installed at several sites so that the
21 elevation of specific water bodies may be measured. The gauges will be immediately
22 downstream of surface water/sediment sampling stations to minimize the potential
23 for impacting the surface water/sediment sampling station during placement of the
24 gauge. The gauge itself will consist of an approximately one-half to one-inch
25 diameter steel pipe manually driven into the streambed. The top of the pipe will
26 extend approximately three feet above the surface of the water. The elevation of the
27 top of this steel pipe will be surveyed to the nearest 0.01 foot MSL by a licensed
28 New Jersey land surveyor.

29 To maintain repeatability in measuring water levels at the stream gauges, an
30 additional benchmark shall be established on a nearby large tree or other stationary
31 object at each stream gauge. This benchmark will enable the stream gauge to be
32 easily reconstructed should it be damaged or displaced. The benchmark will also be
33 surveyed to the nearest 0.01 foot MSL by a licensed New Jersey land surveyor.

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16.5 DECONTAMINATION PROCEDURES AND RESIDUALS MANAGEMENT

The following subsections outline the decontamination procedures for field investigation equipment and the management of residuals (investigation-derived wastes) generated during RI field programs. Decontamination procedures will be performed prior to the equipment's first use at the site and at the conclusion of its use at an investigation location. To ensure the effectiveness of decontamination procedures, periodic equipment rinse blanks will be collected and submitted for chemical analysis (see Subsection 17.3.2 of this Technical Plan for the QA sample schedule). To minimize the potential impact from trace constituents present in decontamination fluids, the following standards will be met: organic reagents (hexane and methanol) will be pesticide grade or better, nitric acid will be ultra pure, and deionized water will not contain analytes of interest at concentrations above the USAEC CRL.

16.5.1 Decontamination of Laboratory Analytical Sampling Equipment

Equipment used for the collection of laboratory analytical samples, including but not limited to split-spoon samplers, groundwater bailers, stainless steel spoons, spatulas, and bowls, as well as sediment core samplers, will be properly decontaminated using the following procedure:

- Wash and scrub with Alconox or equivalent (low phosphate detergent)
- Rinse with USAEC-approved water
- Rinse with 10 percent nitric acid (HNO_3) solution for stainless steel equipment (HNO_3 used for decontamination will be ultra-pure grade)
- Rinse with 1 percent HNO_3 solutions for carbon steel equipment
- Rinse with USAEC-approved water
- Methanol followed by hexane rinse (methanol and hexane used for decontamination will be pesticide grade or better)
- Deionized water rinse (five times the volume of solvent used)
- Air dry or nitrogen blow dry
- Wrap in aluminum foil (shiny side out)

Surface water samples are collected using laboratory pre-cleaned sample containers and therefore do not require decontamination procedures.

1 **16.5.2 Decontamination of Water Pumps and Monitoring Well Screen**

2
3 Equipment that comes in contact with groundwater but is not used in the direct
4 collection of an analytical sample, such as submersible pumps and associated hose,
5 monofilament line for bailers, and PVC well screens, will be decontaminated by the
6 following procedure:

7

- 8 • Wash with approved source water and Alconox or equivalent
- 9 • Rinse with approved source water (not applicable to screened auger
- 10 sampling)
- 11 • Rinse with deionized water
- 12 • Wrap in clean polyethylene for transport

13

14 If disposable equipment, such as nylon rope or hose, are used on a one-time basis
15 these will require decontamination if they are used in the direct collection of
16 analytical samples. In this instance they will be prerinced with soapy water and
17 deionized water.

18

19 **16.5.3 Decontamination of Drilling and Test Pitting Equipment**

20

21 Drilling tools (i.e., augers, drill rods and test pitting equipment) will be
22 decontaminated according to the following USAEC procedure:

23

- 24 • Hot water wash
- 25 • High pressure hot water rinse
- 26 • Air dry

27

28 Augers and drilling equipment will be placed on clean polyethylene sheeting during
29 transport and will be placed on polyethylene sheeting at the drill site.

30

31 **16.5.4 Field Instrumentation Probes**

32

33 Field instrumentation probes (specific conductance, pH, temperature, D.O., and
34 turbidity) will be rinsed with deionized water after each use.

35

36 **16.5.5 Filters**

37

38 Reusable field filters used to filter aqueous metals samples will be decontaminated
39 according to the following procedures:

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- 1 • 10 percent nitric acid wash
- 2 • analyte free deionized water rinse
- 3
- 4

16.5.6 Residuals Management

6 The management of residuals (investigation-derived wastes) produced during field
7 activities (including but not limited to purge water, development water,
8 decontamination fluids, soil cuttings [from soil borings with total depths greater than
9 25-feet bgs], excess grout, drilling fluids, field laboratory wastes, and personal
10 protective equipment) will be containerized in appropriate DOT-approved containers.
11 The drums will be labeled with date, contents, and source (e.g., boring number or
12 monitoring well number) and staged according to contents to facilitate proper
13 management. The containers will be disposed per decision of the NJDEP and the
14 U.S. Army. RCRA requirements are considered ARARs for this RI investigation at
15 Fort Dix. This includes the management of investigation derived waste during field
16 activities. Off-site transport of materials may need to comply with Part 262 and 263
17 standards if the materials being transported are considered hazardous. The shipment
18 of hazardous waste off-site to a treatment facility should be consistent with OSWER
19 Off-Site Policy Directive Number 9834.11.

20

16.6 SURVEYING OF SAMPLING LOCATIONS AND TOPOGRAPHIC MAPPING

24 Soil borings and groundwater monitoring wells installed during this study will be
25 surveyed by a professional land surveyor (licensed in the State of New Jersey), who
26 will use a UTM and State Planar, latitude and longitude grid accurate to within ± 1
27 foot to establish the well's/boring's map coordinates. Elevations for the natural
28 ground surface at each well and the top of the PVC casing will be calculated to
29 within ± 0.01 feet using the NGVD of 1929. The remaining exploration locations
30 (i.e., screened auger, Geoprobe, surface soil, surface water/sediment, staff gauges)
31 will be horizontally located to latitude and longitude with a hand held global
32 positioning system (GPS).

33 Topographic base mapping be conducted at several sites (POL, Golf Course Leaking
34 Tank, ARDC Test Site, Range Landfill, and ANC-2 Disposal Area). Detailed
35 descriptions of this mapping are presented within the individual sections for these
36 sites in this Technical Plan. Mapping proposed for the remaining sites includes
37 supplementing existing site maps with GPS location of additional explorations,
38 significant land and cultural features, and surface water drainage pathways on the

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1 site. At sites not subject to detailed topographic mapping, general topography will
2 be established using USGS 7.5 minute topographic maps.

3 Resurveying of existing monitoring wells will be determined based on the following
4 criteria:

5

- 6 • Field observations do not agree with mapped locations in the Phase II
7 Remedial Investigation Report, Fort Dix New Jersey, Draft Final,
8 USATHAMA, 1992;
- 9 • Monitoring well survey data does not exist; and
- 10 • Monitoring wells exhibiting anomalous water level readings.

11

12

13

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17.0 ANALYTICAL PROGRAM

Field analytical services for this investigation will be provided by the Contractor and are presented in Subsection 17.2 of this Technical Plan. Laboratory analytical services in support of this investigation will be provided by the laboratory Subcontractor, which is validated by the USAEC MRD and certified by the State of New Jersey. Services to be provided for this investigation include: preparation and shipment of bottles cleaned according to USAEC specifications; sample tracking; analysis of samples by USEPA methodologies in accordance with USAEC QC requirements; laboratory QC; and data reporting, as required for the QC and data management functions. Details of the laboratory analytical program are presented in Subsection 17.3 of this Technical Plan.

The laboratory Subcontractor will analyze or subcontract, as necessary, selected samples for USEPA TCL VOCs; USEPA TCL SVOCs; USEPA TAL inorganics, pesticides/PCBs, explosives, TOC, BOD₅, COD, TSS, TDS, alkalinity, herbicides, gross alpha, beta, and gamma radioactivity, and TPH. Tables 5 through 8 summarize the analytical efforts that will be performed to support this investigation, including the types and number of analyses to be conducted, the analytical method used to perform the analyses, and the approximate number of QC samples to be collected.

17.1 SAMPLE IDENTIFICATION AND LABELING

The sample identification system developed for this RI effort enables unique sample identification to be applied to each sample collected. The system has been developed to be consistent with the requirements of IRDMIS and, to the extent practicable, with the previous sampling efforts at Ft. Dix. Each exploration location will be assigned a unique identifier (the "Site ID"). However, as many explorations will have more than one analytical sample collected a unique identifier will also be assigned to each sample (the "field sample number"). The field sampling number will serve as the principal analytical data tracking identifier. The protocols for assigning Site IDs and field sampling numbers is described below.

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17.1.1 Site ID

The following protocols are used for assigning Site IDs. Each Site ID consists of seven alpha-numeric characters and one hyphen (e.g., GTG-01A). The first two characters are letters that assign the Ft. Dix site designations as follows:

- PL Petroleum Oil Lubricant Area (POL), Site 2
- FT Fire Tank Training Area (FTTA), Site 3
- GT Golf Course Leaking Tank Area, Site 4
- TM Transportation Motor Pool Area (TMP), Site 5
- AR Armament Research Development Center (ARDC), Site 6
- PC Pesticide Control Shop, Site 8
- NE New Egypt Armory (NEA), Site 9
- RL Range Landfill (RL), Site 10
- A9 ANC-9, Site 11
- A2 ANC-2, Site 12
- BB Boiler Blowdown Area, Site 13
- DL Area North of Dogwood Lake, Site 14
- GP Golf Course Pesticide Mixing and Storage Area, Site 15

The third character specifies the type of exploration:

- S surface and subsurface soil samples from hand augers and test pits .
- D sediment sample from ditches, streams, ponds, etc.
- W surface water sample from ditches, streams, ponds, etc.
- G groundwater sample from monitoring wells
- A field screening groundwater sample from screened augers and Geoprobe
- B soil samples from soil borings.

The fourth character is a hyphen.

The fifth and sixth characters are numbers representing the specified exploration number (e.g., 02 indicates exploration number two and 10 indicates exploration number 10).

1 The seventh character is a letter which is used to distinguish between different
2 monitoring wells in a given cluster (e.g., "A" denotes a shallow well, "B" denotes an
3 intermediate well, "C" denotes a deep well, etc.).
4

5 **17.1.2 Field Sampling Number**
6

7 The field sampling number is a unique identifier individually assigned to each
8 analytical sample. The field sampling number includes the Site ID information as
9 well as sample depth and QA/QC information. The maximum number of alpha-
10 numeric characters in the field sample number is eight (e.g., GTB0199X). The
11 following protocols are utilized to assign field sampling numbers.
12

13 The first three characters in the field sampling numbers are assigned in the same
14 fashion as the Site ID above.
15

16 In the fourth character the hyphen utilized in the Site ID is deleted. The fourth and
17 fifth character are then utilized to assign numbers representing the specified
18 exploration (e.g., 02 indicates exploration number two and 10 indicates exploration
19 number 10).
20

21 The sixth and seventh characters are used to specify the sample depth. The only
22 exception to this is in monitoring well samples where the letter designations
23 presented in the Site ID are again applied. In this case, the unused sixth character
24 is assigned an "X".
25

26 The eighth character may specify sample depth or a field duplicate or field screening
27 confirmatory sample. If subsurface soil samples are collected from depths greater
28 than 100 feet bgs this character will be used to indicate that (e.g., a Site ID ending
29 in "125" would indicate a soil sample collected at 125 feet bgs). Field duplicates will
30 be denoted with the letter "D". Field screening confirmatory samples will be denoted
31 with the letter "C". Samples which are not collected from depths greater than 100
32 feet bgs and are not duplicates or field confirmation samples will be denoted with
33 an "X". It is not anticipated that field duplicates will be collected from depths
34 greater than 100 feet.
35

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17.1.3 Sample Labels

Preprinted computer generated sample labels will be used. Labels will be covered with polyethylene tape to prevent the loss of the label during shipment. The sample label will include the following information:

- Site ID,
- Field sample number,
- Sample date,
- Sampling time,
- Preservative, if applicable,
- Analyte(s) and analytical method, and
- Samplers initials.

17.2 ANALYTICAL PROCEDURES FOR FIELD SCREENING SAMPLES

Samples will be analyzed for selected VOCs, metals, pesticides, herbicides, TPH, and UV using field analytical techniques. These field analyses will provide real-time data for use in decisions by on-site personnel. The following subsections generally describe the field analytical techniques selected for investigations at the 13 Sites. Detailed standard operating procedures and QA/QC programs are presented in Subsection 2.7 of the QAPP.

17.2.1 Volatile Organic Compounds

The field analytical protocol for VOCs in selected soil and groundwater samples is based on USEPA laboratory procedures, where a "purge-and-trap" sample concentration device is used to achieve detection limits in the 1 to 5 ppb range. The purge-and-trap process involves purging a measured amount of sample with helium, which strips VOCs from the sample and then traps them on a polymer trap. This trap is then heated rapidly, transferring the VOCs to the GC instrument for separation, identification, and quantitation.

17.2.2 Herbicides (2,4-D)

Selected soil samples will be analyzed for the herbicide 2,4-D in the field using enzyme-linked immuno-sorbent technology. This immunoassay procedure involves a sample tube coated with a material to which an antibody specific to 2,4-D residues

1 has been linked. When the sample is introduced to this antibody-treated material,
2 2,4-D residues adhere to the antibody, forming an immune complex. A color
3 developer is then added to the sample tube, and the resulting color is inversely
4 proportional to 2,4-D concentration.

5 **17.2.3 Pesticides**

6 Selected soil samples will be analyzed in the field for pesticides. The analytical
7 protocol was adapted from procedures developed by USEPA. An aliquot of the
8 sample is placed in a test tube to which a small volume of hexane has been added.
9 The test tube is capped and shaken on a vortex mixer to extract the pesticides from
10 the sample into the hexane solvent. The extract is then injected into the GC
11 instrument for separation, identification, and quantitation.

12 **17.2.4 Total Petroleum Hydrocarbons**

13 Selected soil and groundwater samples will be analyzed in the field for TPH by IR
14 spectroscopy and assessment of non-aqueous phase liquids by ultraviolet screening.
15 The field analytical procedure for TPH measures the sum of the hydrocarbons
16 present, rather than the individual compounds. It is based on USEPA laboratory
17 procedures, modified for field use and to encompass a wider range of compound
18 classes. A microextraction is performed on a measured amount of sample using
19 Freon-113 as a solvent. TPH is then measured in the Freon extract using an infrared
20 spectrometer set to a wavelength of 2930 cm⁻¹. The UV procedure, presented in
21 the QAPP, is similar.

22 **17.2.5 Quality Control for Field Analytical Techniques**

23 QC procedures are established prior to initiation of a field analytical program and
24 implemented throughout sample collection and analysis to ensure that generated data
25 are adequate for their intended uses. The QC program provides information to
26 evaluate data quality and analytical system performance while not inhibiting the
27 ability to generate daily analytical data, which is the primary goal of field analytical
28 techniques.

29 The calibration curves for VOCs, pesticides, and TPH analyses are generated by
30 analyzing the appropriate standards at a minimum of three concentrations.
31 Concentrations of the compounds detected in field samples are then calculated from
32 this calibration curve. A calibration check standard (a standard with a concentration
33

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1 in the mid-range of the calibration curve) is analyzed daily to ensure the instrument
2 response does not drift. If the results for the calibration check standard are not
3 acceptable, a new calibration curve is generated before any samples are analyzed.
4

5 Method blanks (laboratory pure water) are analyzed daily to show that the analytical
6 system is free of contamination. Equipment blanks (water run through the sampling
7 apparatus) are analyzed to show that cross-contamination is not occurring during
8 sample collection. Cleaning blanks for the GC instruments are also analyzed after
9 any highly contaminated sample to verify that instrument carryover of contamination
10 is not occurring.

11 Spikes (chemicals added at a known concentration to a sample prior to analysis) are
12 used to evaluate the accuracy of the analytical method. A surrogate, a compound
13 that is chemically similar to those being analyzed, is added prior to sample analysis
14 for VOCs and pesticides to assess recovery (accuracy). Matrix spikes are analyzed
15 as part of the QC program for VOCs, pesticides, herbicides, and TPH. A sample is
16 analyzed unspiked to get the baseline concentration. The sample is then spiked with
17 the compounds being analyzed to evaluate their recovery in the actual sample matrix
18 to provide information on potential matrix effects that could affect the analytical
19 result.
20

21 These elements of a QC program allow for the evaluation of the quality and usability
22 of field screening results. Blanks, surrogate spike, and matrix spike analyses provide
23 information on the accuracy of the field screening methods. Duplicate analyses of
24 field samples or of matrix spikes are incorporated into the program to provide
25 information on method precision. These data can be used to show that the analytical
26 system was operating within the required parameters and that the generated sample
27 results are acceptable for use.
28

17.3 LABORATORY ANALYTICAL PROGRAM

31 Baseline analytical services supporting this investigation will be provided by a
32 laboratory that is validated by USAEC MRD and certified by the State of New
33 Jersey. Analytical services to be provided for this investigation include: preparation
34 and shipment of bottles cleaned according to USAEC specifications; sample
35 preservation; sample tracking; analysis of samples by USAEC methods and in
36 accordance with USAEC QC requirements; laboratory QC; and data reporting, as
37 required for QC and data management functions. Section 18.0 of this Technical Plan
38
39

provides a discussion of QA/QC and Section 19.0 provides a discussion of data management, including sample tracking.

17.3.1 Sample Shipment/Chain-of-Custody

The attending Contractor site geologist or engineer will supervise and assist in all sampling activities. Samples will be labeled and preserved as described in the QAPP. Samples will be packed in plastic coolers with sufficient ice packs or double-bagged ice to maintain 4°C from the time of collection to receipt by the laboratory. If samples are collected on a Saturday or Sunday and held for shipment until Monday, their temperature will be maintained at 4°C to ensure sample integrity. If loose ice is to be used, it will be double-bagged to prevent contact of the meltwater with the samples. All samples will be checked for integrity and lid closure to prevent leakage.

Chain-of-Custody (COC) and Field Parameter Forms identifying all sample containers, analytical requirements, preservatives, and other field data required by the laboratory will accompany each cooler to the laboratory. The procedure for filling out these forms is provided in Subsection 5.5 of the QAPP. In addition, all coolers will be affixed with COC seals and will be shipped via overnight carrier for next-day delivery. The laboratory will be notified of the sample shipment and estimated time of arrival.

Samples will be shipped to the laboratory within 24 hours of collection. However, in select instances (e.g., samples collected late on Saturday afternoon) it may be necessary to hold the samples for an extra day. Under these circumstances, sample delivery to the laboratory will be coordinated to minimize the potential for exceeding sample hold times prior to laboratory analyses.

Upon arrival at the laboratory, the cooler will be opened by designated laboratory personnel who will verify the integrity of the custody seal, check the contents of the cooler against the COC, inspect and record the condition of each sample container, and sign the COC form. Any broken sample bottles or loosened sample jar lids at the time of laboratory receipt will be reported to the Contractor so that additional sampling may be conducted.

17.3.2 Quality Control Samples

QC samples to be collected during this investigation include field rinse (sample) blanks and trip blanks (Subsection 5.4.1 of the QAPP). The purpose of collecting

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1 these samples is to monitor and qualify contamination introduced during laboratory
2 and/or field activities as well as monitor sampling and analytical precision. The
3 following describes these QC samples:

- 4 • *Duplicate Sample.* A sample introduced into the train of environmental samples to monitor the analytical precision of the laboratory methodology and field sampling procedures and for verification of concentrations of an environmental sample.
- 5 • *Rinse Blank.* A sample collected from the decontaminated equipment used during sampling to monitor the integrity of decontamination and the potential for cross-contamination between sampling sites. Demonstrated analyte-free water will be used to prepare these blanks.
- 6 • *Trip Blank.* A sample containing demonstrated analyte-free water that is transported to the sampling site and returned to the laboratory, to ensure that no contamination has been introduced during shipment. The trip blanks will be pre-preserved in the laboratory with hydrochloric acid to pH<2.

21 **17.3.3 Performance Demonstration and Data Review**

22 Samples will be analyzed by the Subcontractor laboratory in accordance with USEPA analytical methods and USAEC QC requirements. The laboratory will be validated by the USAEC MRD for the analysis of baseline analytes of concern at the 13 Sites. The laboratory provides weekly QC submittals to USAEC validated in the form of QC charts. USAEC is responsible for reviewing the analytical data analyzed by USAEC validated methodology and evaluating the compliance of the data to the USAEC Guidelines for Implementation of ER 1110-1-263 (USATHAMA, 1990). The Subcontractor chemists are responsible for reviewing and determining potential limitations within available USEPA guidelines for analytical data analyzed by non-USAEC validated methodologies.

33 Methods that do not require USAEC validation include the following parameters: oil and grease, TPH, BOD₅, COD, TSS, TDS, alkalinity, hardness, gross alpha, beta, and gamma radiation, and TOC. Data review and determination of limitations for these methodologies will be completed and encompass three fundamental elements:

- 1 • The analytical data will be evaluated against the method-specific
2 requirements to ensure that the method requirements have been met;
- 3 • Limitations of the database will be established through relevant
4 guidance documents; and
- 5 • Technical quality of the data will be assessed and any potential
6 limitations to the database will be fully documented and cross-
7 referenced to the associated raw data.
- 8
- 9

10 In assessing the method-specific requirements, the following data elements should be
11 reviewed:

- 12 • Sample Collection Data: associated field screening results, sample
13 collection field logs, COC forms, and shipping forms;
- 14 • Sample Analytical Data: nonconformance summary, sample
15 preparation data, raw data from sample data acquisition, and
16 instrument operating parameters;
- 17 • Associated Calibration Data: instrument tuning data, initial calibration
18 data, continuing calibration data, instrument-specific detection limits,
19 instrument operating parameters;
- 20 • QC requirements: surrogate recoveries, instrument and method
21 blanks, field blanks, matrix spike recoveries and precision, laboratory
22 and field duplicate precision, and laboratory control sample recoveries;
23 and
- 24 • Quality Assurance (QA) requirements: performance evaluation
25 samples.
- 26
- 27
- 28
- 29
- 30
- 31

32 Oil and grease, TPH, BOD5, COD, TSS, TDS, alkalinity, hardness, gross alpha, beta,
33 and gamma radiation, and TOC data review will use the guidance of referenced
34 methodology QA/QC requirements and/or laboratory QA/QC protocols. In
35 addition, data evaluation procedures for non-metal inorganic parameters as given in
36 Quality Assurance/Quality Control Guidance for Removal Activities: Sampling
37 QA/QC Plan and Data Validation Procedures (USEPA/540/G-90/004) will be used.
38

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1 The following items will be reviewed by ABB-ES to review and establish data use
2 limitations:

- 3 • Sample Collection Data;
- 4 • Sample Holding Times and Methods of Preservation;
- 5 • Detection Limits Compliance;
- 6 • Documentation that the analytical results are in control and within the
7 linear range of the analysis;
- 8 • Associated calibration data;
- 9 • Associated control checks to confirm that the daily analysis is in
10 control;
- 11 • Documentation of analytical methodology and QC methodology;
- 12 • The potential presence of contamination from field sampling activities
13 (field blanks); and
- 14 • The potential presence of interferences in analytical methods
15 (laboratory blanks).

17.3.4 Chemical Analysis

26 USAEC-validated analytical procedures will be used for analysis of all samples, as
27 applicable, to include the analytes from the USEPA TCL/TAL, herbicides, and
28 miscellaneous wet chemistry procedures, as well as explosives. A Project Analyte List
29 (PAL) is presented in Table 9. Methods that do not require validation include TPH,
30 BOD₅, COD, TSS, TDS, alkalinity, hardness, gross alpha, beta, and gamma
31 radioactivity, and TOC.

32 Summaries of aqueous and solid samples to be collected for chemical analyses are
33 presented in Tables 5 through 8. This subsection briefly describes the analytical
34 methodologies to be used in the RI for the 13 Sites.

1 **17.3.4.1 Volatile Organic Analyses.** Volatiles will be analyzed in accordance with
2 USAEC Class 1M protocols for gas chromatography/mass spectroscopy analysis
3 (GC/MS). VOCs that will be analyzed at the 13 Sites are listed in Table 9.
4

5 **17.3.4.2 Semivolatile Organic Analyses.** Semivolatiles will be analyzed in accordance
6 with USAEC Class 1M protocols for GC/MS analysis. SVOCs that will be analyzed
7 at the 13 Sites are listed in Table 9.
8

9 Analysis for pesticide and PCB constituents and herbicides will be performed in
10 accordance with USAEC CLASS 1P certified protocols for gas chromatography
11 equipped with an electron capture detector (GC/ECD). Compounds that will be
12 analyzed are listed in Table 9.
13

14 Analysis for explosives will be performed in accordance with USAEC Class 1
15 certified protocols using the methodology developed by the Cold Regions Research
16 and Engineering Laboratory (CRREL). Compounds that will be analyzed are listed
17 in Table 9.
18

19 Soil samples will be extracted for total oil and grease and TPH using USEPA 9071
20 Method 3540 and will be analyzed using USEPA 413.2 and Method 418.1,
21 respectively.
22

23 **17.3.4.3 Inorganics.** TAL inorganics will be analyzed in accordance with USAEC
24 Class 1 protocols. Groundwater samples will be analyzed for nonfiltered and filtered
25 metals. The metal constituents will be analyzed using one of the following
26 methodologies: inductively coupled argon emission plasma spectroscopy (ICAP),
27 graphite furnace atomic absorption spectroscopy (GFAA), or cold vapor atomic
28 absorption (CVAA). Cyanide will be analyzed by the spectrophotometric technique.
29 Inorganics that will be analyzed are listed in Table 9.
30

31 **17.3.4.4 Additional Analyses.** TOC is measured by an instrument that converts the
32 organic carbon in a sample to carbon dioxide (CO₂) by wet chemical oxidation. The
33 Lloyd Kahn Method will be used to analyze for TOC in sediment samples. BOD₅
34 will be measured by field probe using USEPA method 405.1. COD will be measured
35 by the titrimetric method using USEPA method 410.2. TSS and TDS will be
36 measured gravimetrically using USEPA methods 160.2 and 160.1, respectively.
37 Alkalinity and hardness will be measured titrimetrically using USEPA methods 310.1
38 and 130.2, respectively. Gross alpha and beta will be measured by USEPA SW846

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1 method 9310, and gamma radiation will be measured by USEPA EMSL
2 method 901.1.

18.0 QUALITY ASSURANCE/QUALITY CONTROL

1 USAEC has developed a leading QA/QC philosophy and specific QC
2 implementation requirements over the past several years. Founded on the concept
3 of project-wide procedures to determine and ensure the reliability, completeness,
4 traceability, and comparability of data and conclusions, specific methodologies for
5 controlling and documenting laboratory and sampling procedures have been
6 developed. This project has been designed to follow the requirements contained in
7 the ER 1110-1-263 (USATHAMA, 1990) to prepare and implement the internal QC
8 Plan. Sections of the QAPP describe organizational responsibilities for data quality,
9 specific procedures for collecting and analyzing data under controlled conditions,
10 procedures for data review for NON-USAEC method data, procedures for preventing
11 and correcting out-of-control situations, and other aspects of QA such as training,
12 documentation, verification, reporting, and recordkeeping.

13 The Contractor will be committed to the precepts of this program:

- 14 a. Planning -- Organizing and developing procedures so that performance
15 measures of systems are known, data quality objectives (DQOs) (i.e.,
16 the level of quality required to support each project objective) are
17 established, and all personnel know what is required and what their
18 individual responsibilities are.
- 19 b. Controlling -- Ongoing quality checks to confirm that all systems are
20 performing as expected, and that personnel are operating the systems
21 as planned and in a timely fashion.
- 22 c. Documenting -- Ensuring that data quality is validated and is traceable
23 through all project stages from collection to archival.
- 24 d. Improving -- Developing more efficient and more exacting procedures
25 for given DQOs.

26 Project deliverables are based on an understanding of the environmental situation
27 at a site, which is derived from data collected during various task activities. The QC
28 plan encompasses and integrates the various aspects of the project (geotechnical,
29 sampling, analytical, testing, and assessment) by requiring data to be representative,
30 precise, and accurate, within characterized limits. Documentation, prepared and

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1 maintained through a document/data control system, will provide the defensible
2 evidence of traceability and adherence to prescribed protocols.

3

4

5 **18.1 QUALITY CONTROL**

6

7 When applied to sampling and chemical analysis, the QC Plan has the specific
8 objectives of: (1) ensuring that the analytical results correspond to the environmental
9 situation at the time a sample was collected; (2) estimating the level of quality of
10 each analytical system sufficient for meeting DQOs; (3) assisting in the early
11 recognition of deficiencies that might affect data quality; (4) enabling the laboratory
12 to take actions to ensure data validity; and (5) enhancing the utility of data
13 considered in the decision-making process, by requiring simultaneous expression of
14 limitations on data quality.

15

16 The QAPP that accompanies this submittal has been designed to comply with the
17 requirements of the ER 1110-1-263 (October, 1990). USAEC-validated analytical
18 methods will be used for analyses, except for select cases where a USAEC-validated
19 method is not required. Sample containers will be cleaned and samples preserved
20 in accordance with USAEC and USEPA Region II procedures. Water and soil
21 sample collection, shipment, and documentation will follow the guidance provided
22 in Section 3 of the USAEC Guidelines for Implementation of ER 1110-1-263 for
23 USAEC Projects (May 1993). Analyses will be monitored by the inclusion of QC
24 samples, results from which will be used to evaluate data acceptability by linking
25 each sample with controls. Results of analytical QC will characterize the criteria for
26 the acceptance of data. Failure to meet these criteria, as monitored by the project
27 QA personnel, will result in immediate cessation of analyses. Clarification and
28 correction of the analytical difficulty may result in acceptance of the data, if justified,
29 or reanalysis of all samples in the analytical lot.

30

31 Project activities will be characterized in written plans (work plans, methods,
32 protocols) and will then be monitored and documented for compliance with these
33 approved procedures. Documentation, including field data, laboratory data, methods,
34 COC records, and logbooks will be maintained according to Section 10 of the QAPP.
35 Data will be validated and archived prior to use in final assessments supporting
36 USAEC decisions.

37

38 As mentioned above, USAEC monitors laboratories through its validation process.
39 This means that all data, COC forms, QC checks, and internal reviews will be

scrutinized by USAEC to ensure the highest quality of data possible. In doing so, USAEC will evaluate three-point moving average and single-day control charts for analytical compliance.

18.2 DATA REVIEW/VALIDATION

Data review and validation of sample results for USAEC-validated methods will be performed by Potomac Research, Inc. (PRI), a Contractor to USAEC. Before transmitting the information to permanent storage, the firm will inspect calibration data, control charts, and any other performance indicators. The evaluation of laboratory data will ensure the implementation of certification protocols and QC measures. The validation of the data will attest to the accuracy and precision of the analytical system.

Data review and validation of sample results for non-USAEC methods will be performed by the Contractor. The validation and review process is discussed in Subsection 6.3 of the QAPP.

Data review and determination of limitations of methodology not requiring USAEC validation will be performed by Contractor chemists. The review procedures for each parameter are outlined in the Subsection 6.3.2 in the QAPP.

18.3 DATA QUALITY OBJECTIVES

DQOs are qualitative and quantitative statements that specify the quality (i.e., level) of the data obtained from field activities that will be required to support decisions regarding remedial response activities. Development and use of DQOs is a USEPA requirement for conducting CERCLA projects and has been described by USEPA in their guidance document, DQOs for Remedial Response Activities (March 1987). The development of DQOs for remedial programs helps ensure that data obtained during remedial programs is of sufficient quality to support remedial response decisions, reduce overall costs of data sampling and analyses activities, and accelerate project planning and implementation. The following factors were considered in determining these DQOs:

- a. The purpose of collecting data from the media associated with each field activity.

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- b. The data types required to meet analytical, chemical, and physical objectives.
- c. A description of the sampling method being employed for each type of data.
- d. The use for which data are being collected. This has been described by using general purpose categories that represent different data uses (e.g., site characterization, alternatives analysis, risk assessment).
- e. The identification of an appropriate analytical level for the analysis (or measurement) being performed. Five such levels have been characterized by USEPA for chemical analyses -- these have been slightly modified to take into account physical measurements.
- f. The analytical method that will be employed to analyze samples.
- g. Evaluation of critical samples, those for which valid data must be obtained to satisfy the objectives of the sampling and analysis task.
- h. The types and numbers of QC samples that will be collected in association with each sampling event/media.

Temperature, pH, and conductivity measurements will be performed to Level I screening. This provides the lowest data quality but the most rapid results. These data will be used primarily for initial site characterization. Health and safety monitoring conducted at the site will also be performed to Level I.

Geotechnical analyses conducted at the site (e.g., hydrologic testing) will be performed to Level II for field analyses. In addition, field analytical results for VOCs, pesticides, herbicides, and TPH will provide Level II data quality.

Laboratory chemical analyses performed for samples will be performed to Level IV equivalent. This includes soil, sediment, surface water, and groundwater samples. This level provides the highest level of data quality and produces data suitable for use in the risk assessment. All chemical analytical samples for the site will be sent to a laboratory certified by the State of New Jersey and validated by USAEC MRD.

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1 Analytical data gathered during previous investigations for which USAEC
2 methodologies at the site were followed, will be assumed to be Levels III and IV
3 data that have had appropriate QA/QC verification. Unless data can be validated,
4 all other previous site data will be assumed to be Level II.

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19.0 DATA MANAGEMENT

1 Proper data management during this investigation will enable and facilitate reliable
2 and defensible conclusions. Experience in conducting environmental surveys and
3 assessments has shown that organization plays a key role in ensuring that the large
4 quantities of data collected in support of a particular project are put into a form that
5 is easy to review and understand.

19.1 ORGANIZATION

10 The Task Manager is responsible for data management activities. The Contractor
11 is responsible for initial data management of non-chemical field data. In addition
12 to handling administration, coordination, and operations associated with the project,
13 the Task Manager will periodically monitor the flow of data to ensure that schedule,
14 technical quality, and resource requirements are met. The Task Manager will also
15 be responsible for briefing technical personnel on the requirements of the project,
16 and for identifying and resolving any technical problems concerning data
17 management.

18 The Program Data Coordinator (PDC) will handle the day-to-day monitoring of data
19 management activities by ensuring that the collected data are properly coded and
20 entered into the IRDMIS. The PDC will also have the authority to enforce proper
21 procedures, and to implement actions to ensure the accurate and timely flow of data.

22 The QA Supervisor will be responsible for auditing and secondary review of data
23 records that have been coded and checked by the PDC to ensure they are accurate,
24 complete, and supported by adequate documentation.

25 The Field Sampling Team, which will be directed by the Site Operations Leader
26 (SOL), will be responsible for collecting and documenting the data on field
27 parameter forms in the appropriate field logbooks (see the QAPP also included with
28 this submittal). The SOL will ensure that the completed forms are checked for
29 accuracy and presented to the PDC in a timely manner.

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1 19.2 INSTALLATION RESTORATION DATA MANAGEMENT INFORMATION SYSTEM 2 (IRDMIS)

3 19.2.1 System Description

4
5 The IRDMIS is an integrated system for the collection, validation, storage, retrieval,
6 and presentation of Installation Restoration and Base Closures data. The IRDMIS
7 PC Tool, a major component of IRDMIS, provides the ability to enter chemical,
8 geotechnical, and map data in support of the USAEC Installation Restoration and
9 Base Closure Programs. Each Contractor is supplied with appropriate
10 microcomputer-based software to allow for record entry, error checking, and QC for
11 chemical, geotechnical, and map data into IRDMIS. Records accepted by the local
12 error checking program are then transmitted through a Bulletin Board System (BBS),
13 AT&T Model 3B2 minicomputer, which is centrally located at the USAEC
14 Edgewood, Maryland, facility. Subsequent processing (duplicate error check) at PRI
15 results in an elevation of the accepted records to a higher file "level" and the
16 eventual updating of installation-specific databases on a Pyramid System. It is
17 understood that the Army is in the process of changing supporting hardware;
18 however, it is expected that the procedures for data entry, validation, and archiving
19 will remain the same.
20

21 19.2.2 Data Management

22
23 There are three levels of data recognized in the IRDMIS. Level 1 consists of files
24 on the Contractor microcomputer that have been entered or generated by the error
25 checking program. Once data have been entered in the IRDMIS, that data will be
26 checked by both the PDC and the QA Supervisor. These data are then archived
27 into a transfer file and transmitted via modem to PRI.
28

29
30 It is anticipated that error-free files will be transmitted weekly to the PRI local area
31 network. The Contractor's computer terminal will be linked to the network using
32 software supplied by USAEC and a Hayes modem. Terminal usage logs will be
33 established and maintained as a permanent record of communications. If
34 communications cannot be established and maintained, the Contractor will seek
35 optional means, where needed, for forwarding the data to USAEC. Once the
36 transfer file has been transmitted, the PDC will contact PRI by telephone to notify
37 them of the transmittal. Each Monday, PRI will send a telefax to the Contractor
38 listing the files received and the acceptance status. To verify acceptance, PRI will
39 process each file through an error checking program identical to the one on the

1 Contractor's computer. Accepted files will then be sent to the UNISYS mainframe.
2 Should any files fail this final error check, the Contractor will be notified and
3 required to correct detected errors and retransmit the data.

4 Upon arrival at the UNISYS mainframe, the files will be classified as Level 2 files.
5 Level 2 files will exist only until the data are loaded into the USAEC database,
6 normally within 10 working days.

7 Data in the USAEC database are considered Level 3 data. They may be accessed
8 by the Contractor using USAEC-supplied report programs and the appropriate read
9 key; however, they are protected from changes by a write key.

10 Data management begins when USAEC and the Contractor transmit a request for
11 analytical services to the laboratory, stating the number, type, sample numbers,
12 methods for analysis, and any other information necessary for the laboratory to plan
13 a particular job.

14 While in the process of collecting, documenting, packaging, and shipping samples to
15 the laboratory, the field sampling team will record field parameter information in the
16 appropriate logbook. Once the samples arrive at the laboratory, the site type/Site ID
17 information will be combined with analytical results, by analytical lot, and the
18 information entered into Level 1 data files in the IRDMIS. The laboratory will
19 validate the data, perform error-checking and correction using the USAEC routines,
20 and transmit the Level 1 files to USAEC, via the 3COM communications network.
21 Hard-copy documentation will also be transferred from the laboratory to USAEC.
22 The field sampling team will transmit location information from the field logbook to
23 the PDC, who will input the data into map files for the site. The map files will be
24 checked against the original field logbook entries.

25 Once the Level 1 files have been processed at USAEC, the PDC will transmit any
26 required corrections, then generate a backup disk copy. This step will be completed
27 within 50 days after the samples have been collected. The laboratory will archive
28 copies of analytical data, including original instrument magnetic tapes, until approval
29 for release is obtained from USAEC. Records will also be maintained, so that
30 historical summaries of analyses may be generated. Figure 14 presents a summary
31 diagram of how these data will be handled.

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33
34
35
36
37

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19.3 PROJECT DATA

2
3 Data for entry into the IRDMIS and generated during this project will consist of
4 geotechnical data and sampling/analytical data. Data that are not entered into the
5 IRDMIS will be logged into notebooks, then packaged with any hard-copy outputs
6 (e.g., plots, charts), and sent to the PDC. Both the PDC and a secondary reviewer
7 will review these data, referred to as field data, before the PDC archives the
8 information for future reference. The types, origin, IRDMIS files, and handling of
9 these data are described below.

19.3.1 Map File Data

13 A Geotechnical Map File (GMA), an IRDMIS geotechnical data file type, will be
14 generated by the field team activities during the investigation at Ft. Dix. The GMA
15 contains locational information about groundwater monitoring wells and soil samples.
16 These files are generated from field logbooks, boring logs, and field parameter forms
17 used by the Site Geologists and must precede all other data files for a particular site
18 type and Site ID.

19 The map file is a listing of sample sites and corresponding location coordinates. Map
20 files will be created from the sample site data, and input into the IRDMIS.
21 Elevation and locational coordinates are obtained by surveying (wells) or from maps
22 (other sampling points), and are submitted by the SOL to the PDC, who creates the
23 map file. These data are entered into the computer by the PDC, and a computer
24 printout of the file is checked and corrected by the SOL.

19.3.2 Field Drilling and Well Construction Files

29 During and after completion of well drilling activities, the Site Geologist enters field
30 drilling data on USAEC's IRDMIS forms and submits them to the PDC. The
31 information is entered into the data management system, and a computer printout
32 is generated and returned to the Site Geologist for proofing. Corrections are noted
33 on the sheet, and the sheet is returned to the PDC. After corrections have been
34 made, the data are submitted to USAEC and loaded onto the USAEC data system
35 in Level 1. Once the field drilling and well construction files are submitted to
36 USAEC in Level 1, the data are checked with USAEC's GEOTEST program, which
37 checks for correspondence between sites in the map and field drilling files, accurate
38 entry of data, and completeness in the field drilling and well construction files.

1 Errors are printed out for correction in the Level 1 file. After the QA Supervisor
2 has validated the field drilling and well map file, the data are elevated to Level 2.
3

4 **19.3.3 Groundwater Stabilized File**

5 The groundwater-stabilized file is a compilation of static water levels in the wells at
6 the time of sampling. It is submitted by the Site Geologist after the sampling trip,
7 along with the map file information. The groundwater-stabilized file is submitted on
8 IRDMIS forms and undergoes the same entry, checking, and validation procedures
9 as the field drilling and well construction files.
10

11 **19.3.4 Sampling and Analytical Data**

12 Field screening data from field analytical laboratory work will be kept in a separately
13 bound logbook. In addition, during the field program, field screening data will be
14 uploaded to electronic format for use in plotting to assess horizontal and vertical
15 distribution of contaminants.
16

17 Data from analyses performed by the analytical laboratory are input into various
18 chemical data files. The laboratory is also responsible for validation of the data for
19 generation of error-free files. Data from sampling activities required by the
20 laboratory will be submitted by the sampling team on field parameter forms, along
21 with the samples. The sampling organization will also be responsible for generation
22 of all map files, as described above. A description of sampling and analytical data
23 generation and manipulation is provided below.
24

25 Subsection 17.1 of this Technical Plan specifies the Site ID and field sample number
26 system. Sampling data will be collected in the field in a permanently bound logbook.
27 Information will be recorded on two-part field parameter forms. Each logbook will
28 be specific to the matrix being sampled. This information will include the site type,
29 Site ID, sampling date and time, field sampling number, sample depth (if applicable),
30 and the sampling technique. One copy of this form will accompany each sample to
31 the laboratory so that the information can be encoded prior to sample analysis. In
32 addition, each sample container will be annotated in waterproof ink with the
33 installation name, sampling number, sampling date, analytes, and preservatives. A
34 COC form will also be completed in the field and will accompany the samples to the
35 laboratory, along with the field parameter form. One copy of the field parameter
36 form is bound in the logbook for use in creating map files.
37

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1 Collection of analytical data will begin when samples arrive at the laboratory. A
2 laboratory technician will first verify that the samples noted on the COC form
3 coincide with the sample containers being delivered. If any containers are broken
4 or missing, the COC form will be annotated and the SOL will be notified
5 immediately. Samples will then be logged into a project-specific notebook and the
6 computerized laboratory data management system according to parameter code,
7 site ID, field sample number, and laboratory sample number. The field parameter
8 and COC forms will then be submitted to a laboratory data technician for later
9 correlation with the analytical results.

10 Upon receipt of the sample log information, the laboratory Quality Assurance
11 Coordinator (QAC) will assign analytical lot numbers to the samples in accordance
12 with USAEC procedures. The first three letters of the six-character sample code will
13 designate the analytical lot, while the remaining three digits will indicate the sample
14 number within the lot (e.g., AAB006 indicates the sixth sample in lot AAB). All QC
15 samples required for each analytical lot (e.g., method blank, control spike at two
16 times the certified reporting limit (CRL), and two control spikes (at 10 times the
17 CRL) will also receive USAEC sample numbers. The data technician will enter the
18 sample information into the IRDMIS to generate partially completed data coding
19 forms.

21 When the samples are taken from storage for analysis, the COC form will be signed
22 by the Data Analyst to acknowledge receipt of the samples for processing. When
23 analyses are complete, the Data Analyst will evaluate the data for QC samples to
24 determine if the analyses were in control. The QC results will then be reviewed by
25 the Laboratory Section Manager and forwarded to the QAC for verification. If the
26 QAC agrees that the data are in control, the Data Analyst will be directed to
27 proceed with data reduction for the samples. Concentrations of contaminants in
28 extracts will be determined from instrumental responses of the extracts applied to the
29 instrument calibration curve. The resulting concentration will then be modified by
30 applying the appropriate dilution/concentration and sample weight or volume to
31 obtain a final reportable concentration in the original matrix. Soil sample results will
32 not be corrected for moisture, but percentage of moisture will be reported with the
33 result. Aqueous samples will be reported in terms of $\mu\text{g}/\text{L}$ and solid samples will be
34 reported in mg/kg.

36 The data will contain no more than three significant digits and will be rounded to the
37 appropriate number of significant digits, based on certification class and dilution, only
38 after all calculations have been completed. When samples are diluted into a certified
39

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range, the reported concentration will contain one less significant digit than an undiluted sample. Values less than the CRL will be reported as "less than" the CRL. If a sample is diluted below the CRL, the value will be reported as "less than" the CRL multiplied by the dilution factor to more accurately reflect the observable limit. The dilution factor will be reported with the data. Method blank values will not normally be subtracted from sample results submitted to IRDMIS; however, method blank corrections may be made in accordance with the USATHAMA QA Program 1990 3rd ed., Subsection 11.3.1. It should be noted that data deletions as a result of qualifications from blank contamination will occur only during the risk assessment phase.

When data reduction has been completed for the samples, all data will be transmitted to USAEC. The correlation of the analytical and field data will be performed by PRI. Table 10 lists the information that is required for the IRDMIS.

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20.0 RISK ASSESSMENT

Baseline Human Health and Ecological Risk Assessments will be conducted for appropriate sites at Ft. Dix. The purpose of these assessments will be to establish the potential risks to human and ecological receptors. Based on the results of these baseline risk assessments (risks in the absence of remediation), one of the following recommendations will be made for the 13 Sites:

- 1 1) take no further action or initiate long-term monitoring
- 2 2) initiate an immediate removal or interim action, or
- 3 3) prepare an FS

The Human Health and Ecological Risk Assessments will be conducted in accordance with USEPA guidance for conducting risk assessments at Superfund sites. This includes Risk Assessment Guidance for Superfund (RAGs) Volume I, Human Health Evaluation Manual, and Volume II, Environmental Evaluation Manual. In addition, NJDEP's Guidance for Sediment Quality Evaluations (March 1991) will be followed. Additional guidance documents are presented in Task Order Number 0006.

20.1 HUMAN HEALTH RISK ASSESSMENT

The following subsections detail the approach to the Human Health Risk Assessment to be performed.

20.1.1 Identification of Chemicals of Potential Concern

The first step in the risk assessment will be the review of the validated analytical results from sampling completed during the RI, as well as other site-specific information, to identify chemicals of potential concern for detailed study in the risk assessment. Factors considered in selecting a chemical of potential concern include the chemical's relationship to the suspected source or to past activities at each site, and the relationship of the detected chemical concentration to site-specific background or upgradient levels of the chemical as outlined by USEPA (1989).

Before chemicals of concern are selected, the data collected during the RI will be summarized by environmental medium (e.g., groundwater, surface and subsurface

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1 soil, sediment, and surface water) for the 13 Sites. Each chemical detected within
2 a given medium will be summarized by frequency of detection, arithmetic mean,
3 mean sample size, range of detected concentrations, and range of background
4 concentrations.

5 The shape of the data distribution represented by the field data will be evaluated by
6 conducting a small number of "goodness of fit" tests to calculate the appropriate
7 statistics to be used for generation of the arithmetic mean and confidence limits.
8 The arithmetic mean will be calculated using detected values in addition to one-half
9 the detection limit for non-detect values (excluding high detection limits in
10 accordance with USEPA [1989a, guidance⁴]). In addition, the 95 percent upper
11 confidence limit (UCL) of the arithmetic mean will be determined and used for
12 estimating exposure in the risk assessments.

13 For those environmental media with more than 20 organic chemicals, the
14 Concentration-Toxicity Screening Procedure outlined in USEPA (1989a) may be used
15 to select chemicals of potential concern. This procedure will focus the risk
16 assessment on those chemicals contributing the most to potential impacts at each of
17 the sites selected for evaluation. The screening procedure will be based on a
18 chemical's toxicity and concentration, generally the two most important factors in
19 establishing the risk or hazard posed by a chemical.

20 Inorganic chemicals at each of the sites at naturally occurring levels may be
21 eliminated from the quantitative risk assessment based on comparison to background
22 concentrations (USEPA 1989a). If there is a reasonable number of background
23 samples (i.e., a minimum of three or four), a formal statistical analysis will be
24 conducted to compare site-related and background chemical concentrations.
25 Background samples will be collected for groundwater, soil, and surface water/
26 sediment as part of a base-wide Background Sampling Program. If analytical results
27 for these background samples indicate they are not representative or appropriate to
28 use as background, then background regional data could be used.

33 ⁴Note, however, that USEPA guidance indicates that this approach is only appropriate when the
34 fraction of non-detects is less than 10 percent of the total. When a larger fraction of non-detects is
35 present, alternate procedures are required. The budget estimate for this work plan assumes that none
36 of the data sets to be evaluated in these studies contains more than 10 percent non-detects, and that
37 alternative procedures will not be required.

If regional data must be used because of a lack of base-wide background data, and if adequate regional data are not available to conduct statistical analyses, the chemical concentrations in a site-affected medium may be compared to two times the maximum regional background sample concentration. A factor of two is considered conservative because background concentrations of naturally occurring chemicals can range over an order of magnitude. Inorganic chemicals that remain after the comparison to background will be selected and evaluated in the risk assessment.

20.1.2 Human Exposure Assessment

The next step in the risk assessment will be the exposure assessment. The purpose of the exposure assessment is to characterize (quantitatively or qualitatively) the route, frequency, duration, and magnitude of exposure to chemicals associated with the site. The exposure assessment will be conducted in a series of three steps: (1) receptor characterization; (2) exposure pathway identification; and (3) exposure quantification. Exposure will be evaluated assuming that land use does not change in the future and that all study areas will continue to support some type of Department of Defense (DOD) activity.

20.1.2.1 Receptor Characterization. As the first step of the exposure assessment, potentially exposed populations (receptors) are identified for each study area and described with respect to those characteristics that influence exposure. Factors such as activity patterns in the area, source characteristics, and routes of transport are considered when identifying potentially exposed populations. Again, for purposes of the risk assessment, it will be assumed that current and future land use will remain constant. For the human health assessment, it is anticipated that for most study areas, human receptors will be limited to installation personnel and other on-site workers. If the potential exists for Ft. Dix residents to be exposed to chemicals at the 13 Sites, they may be evaluated as potential receptors. In accordance with the U.S. Army and Ft. Dix, future residential development of the study areas will not occur, therefore related exposure scenarios will not be considered.

20.1.2.2 Identification of Exposure Pathways. The exposure pathways associated with each site are identified and are based on consideration of the sources, releases, types and locations of chemicals in each study area; the likely fate and transport of the chemicals; and the location and activity of receptor populations. Each exposure pathway includes: (1) a source and mechanism of release; (2) an environmental transport medium; (3) a point of potential exposure with the contaminated medium; and (4) a route of exposure (e.g., direct contact with soil, ingestion of groundwater)

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1 at the exposure point. Pathways that contain all these elements are considered
2 complete and will be considered for quantitative evaluation in the risk
3 characterization.

4 This exposure assessment will focus on those exposure pathways likely to result in the
5 greatest exposure, which therefore are potentially associated with the greatest risks.
6 This task will predict the potential magnitude, frequency, and duration of chemical
7 exposures through the identified exposure pathways. A discussion will be provided
8 in the risk assessment justifying the selection or exclusion of pathways from
9 consideration. It is anticipated that, at minimum, the exposure pathways selected for
10 quantitative evaluation will include incidental ingestion of soil and ingestion of
11 groundwater. Other potential exposure pathways, such as direct contact or incidental
12 ingestion of surface water and sediment, or inhalation of chemicals that may have
13 volatilized from groundwater while showering, may also be evaluated, depending on
14 whether the pathway would be considered complete. A discussion will be provided
15 in the risk assessment justifying the inclusion or exclusion of pathways from
16 evaluation.

18 **20.1.2.3 Quantification of Exposure.** For each exposure pathway selected for
19 quantitative evaluation, concentrations at the exposure point will be using the RI
20 data. The shape of the data distribution will be evaluated to determine the
21 appropriate statistics to use in calculating the exposure point concentrations. In
22 accordance with USEPA (1989a) guidance, the exposure point concentrations will be
23 the 95 percent UCL of the arithmetic mean, or the maximum detected concentration
24 in a given media and data grouping, whichever is less.

26 Exposures will be quantified for each receptor population and exposure pathway by
27 calculating lifetime average daily doses (LADDs) for exposure to chemical
28 carcinogens, and average daily doses (ADDs) for exposure to noncarcinogenic
29 chemicals, following USEPA (1992) guidance. LADDs and ADDs will be based on
30 the exposure point concentrations and assumptions regarding the frequency and
31 duration of exposures, and the rate of media intake (e.g., amount of water or soil
32 ingested per day). In accordance with USEPA (1989a) guidance, exposures will be
33 quantified assuming a reasonable maximum exposure (RME) scenario.

35 20.1.3 Toxicity Assessment

36 Chemicals of potential concern will be characterized with respect to their toxic effects
37 in humans. Where possible, relevant critical toxicity criteria will be identified for
38

each chemical. Brief summaries of the toxicity of those chemicals that will be evaluated quantitatively in this assessment will be included. For the human health assessment, two types of toxicity values are used: USEPA-derived cancer slope factors (CSFs) and unit risks (URs) for potentially carcinogenic chemicals and reference doses (RfDs) and reference concentrations (RfCs) for chemicals exhibiting noncarcinogenic effects. For carcinogens, CSFs/URs and the chemicals' weight-of-evidence classifications for human carcinogenicity will be provided and discussed. For noncarcinogens, RfDs/RfCs and the uncertainty factors used in deriving them will be provided. The primary source of CSFs/URs and RfDs/RfCs will be USEPA's Integrated Risk Information System (IRIS) and Health Effects Assessment Summary Table (HEAST). The USEPA regional toxicologist and Environmental Criteria and Assessment Office (ECAO) may be contacted for toxicological information, as well as for guidance on the evaluation of chemicals that do not have USEPA-published toxicity values.

20.1.4 Risk Characterization

Potential human health impacts will be evaluated by comparing risk levels associated with estimated exposures to appropriate USEPA- and NJDEP-acceptable risk ranges. The results of the risk characterization will include estimates of the upper-bound individual cancer risk for potential carcinogens and a Hazard Index (HI) for noncarcinogens. The individual lifetime excess cancer risk for a chemical exhibiting carcinogenic effects will be calculated by multiplying the upper-bound CSF by the estimated LADD averaged over 70 years. For noncarcinogens, potential risks will be calculated as an HI, as recommended by USEPA (1989a). An HI greater than one may necessitate additional evaluation, in which HI for groups of chemicals affecting similar target organs will be calculated. If an HI exceeds one for a specific target organ, there may be concern for potential health effects (USEPA, 1989a). Risks will be calculated for each exposure pathway, and where applicable, will be summed across the exposure pathways to predict the combined impact for individuals who may be exposed via several pathways.

20.1.5 Uncertainty Analysis

The risk assessment process involves several steps (e.g., selection of chemicals of potential concern (CPCs), hazard identification, exposure assessment, and toxicity assessment). Each step contains assumptions and uncertainties. The uncertainties involved in risk assessment in general, and the risk assessment conducted for the

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1 study area, specifically, will be characterized. The impact of the uncertainties on the
2 risk characterization, and risk management decisions will be discussed.

3

4

5 **20.2 ECOLOGICAL RISK ASSESSMENT**

6

7 The purpose of the Ecological Risk Assessment at the 13 Sites is to provide a
8 baseline evaluation of actual and potential risks to ecological receptors posed by
9 chemicals in environmental media. The Ecological Risk Assessment will consist of
10 the following elements: Hazard Assessment; Ecological Characterization; Ecological
11 Exposure Assessment; Ecological Effects Assessment; Ecological Risk
12 Characterization; and an Uncertainty Analysis.

13

14 **20.2.1 Hazard Assessment**

15

16 This section will present an overview of the Ecological Chemicals of Potential
17 Concern (COPCs) at the 13 Sites. The selection of COPCs is a screening process
18 used to characterize the chemicals requiring evaluation in the Ecological Risk
19 Assessment. Factors considered when selecting COPCs include: the validity of the
20 data for ecological risk assessment; the classification of chemicals (e.g., inorganic,
21 organic, pesticides); comparison of chemical concentrations with naturally occurring
22 background concentrations; the physical and chemical properties of chemicals; the
23 frequency of release and detection; and the inherent toxicity of exogenous chemicals.

24

25 **20.2.2 Ecological Characterization**

26

27 The ecological characterization will serve as the basis for identifying potential
28 ecological receptors at the 13 Sites. It will describe the different biological habitats
29 (aquatic and terrestrial) located at the sites as well as ecological receptors. The
30 ecological characterization will qualitatively characterize the ecological communities
31 associated with the 13 Sites.

32 This characterization will be based on a limited site reconnaissance. In addition,
33 background information on the 13 Sites will be reviewed, including literature on the
34 range and distribution of wildlife species, and interviews with local, state, and federal
35 wildlife officials. Emphasis will be placed on the following: assessing habitat
36 suitability for aquatic and terrestrial organisms; assessing the potential occurrence of
37 rare, threatened, or endangered species; and identifying wetland or other aquatic
38 areas that may be receptors of site-related contaminants. Additionally, plant
39

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1 communities at the 13 Sites will be described and observations of aquatic or
2 terrestrial organisms will be recorded. The USEPA, NJDEP, U.S. Fish and Wildlife
3 Service (USFWS), New Jersey Natural Heritage Program, and the Pinelands
4 Commission will be contacted regarding the presence of potential receptors. The
5 results of the receptor analysis will be used to further develop exposure scenarios for
6 the Ecological Exposure Assessment.

7
8 Additionally, plant communities at the 13 Sites will be described and observations of
9 aquatic or terrestrial organisms will be recorded. Wildlife and vegetative species
10 encountered or expected to be present at the site will be listed in tabular format.
11 The USEPA, NJDEP, U.S. Fish and Wildlife Service (USFWS), New Jersey Natural
12 Heritage Program, and the Pinelands Commission will be contacted regarding the
13 presence of potential receptors.

14
15 As part of the receptor identification, an informal Section 7 consultation also will be
16 requested from the United States Fish and Wildlife Service (USFWS) to identify
17 endangered or threatened species which may be associated with the site. The
18 National Marine Fisheries Service (NMFS), often consulted for similar information
19 on marine species, will not be notified because the installation is not located near
20 any marine, coastal, or tidal systems, and therefore no threats to these systems are
21 anticipated.

22
23 The New Jersey Natural Heritage Program also will be consulted for information
24 regarding the potential presence of state-listed endangered, threatened, or rare
25 species or communities. A Natural Diversity Inventory is being performed at Fort
26 Dix by the New Jersey Natural Heritage Program which will be a useful tool in
27 identifying species of special concern.

28
29 As part of the ecological characterization, any wetlands on or near a site that could
30 potentially be affected by contamination and/or future remedial actions at a site will
31 be identified and delineated. Delineated wetlands will be classified and depicted on
32 a site map. Potentially affected wetlands will be delineated (and mitigated, if
33 required) in accordance with the most stringent of either the U.S. Army Corps of
34 Engineers (1987 Wetland Delineation Manual), the NJDEP Freshwater Wetlands
35 Protection Act, or the New Jersey Pinelands Commission requirements. A functional
36 assessment of the potentially affected wetlands will be conducted using the Corps of
37 Engineers' Wetland Evaluation Technique (WET) or other appropriate functional
38 assessment model.

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20.2.3 Ecological Exposure Assessment

The Ecological Exposure Assessment will evaluate the potential for receptor exposure to chemical contaminants at the 13 Sites. This evaluation involves the identification of potential exposure routes and an evaluation of the magnitude of exposure of identified ecological receptors. Exposure concentrations and/or doses will be estimated for each exposure pathway. If appropriate, indicator species will be selected for ecological exposure modeling.

Exposure pathways describe how ecological receptors can come in contact with contaminated media and are based on identifying (1) the contaminant source, (2) the environmental transport medium, (3) the point of receptor contact, and (4) the exposure route (e.g., ingestion of prey items that have bioaccumulated chemicals in their tissues, drinking of contaminated surface water, incidental soil ingestion, or dermal absorption).

Ecological receptors at the 13 Sites could potentially be exposed through the following routes:

- Incidental ingestion of and direct contact with surface soil;
- Ingestion of contaminated food items (food chain exposure);
- Direct contact with or incidental ingestion of surface water and sediment; and
- Inhalation of particulate or vapor-phase chemicals.

Aquatic organisms potentially exposed to chemicals in surface water and sediment include freshwater aquatic invertebrates. Animal species most likely exposed to chemicals in sediment include macroinvertebrates living in the sediment or benthic-feeding organisms, as well as fish, amphibians, and certain reptiles. Plant species potentially exposed to surface water and sediment at the 13 Sites include various aquatic, emergent, and facultative wetlands species.

Terrestrial and semiterrestrial organisms that may be exposed to site-related environmental contamination include birds, mammals, reptiles, and amphibians. Potential exposures to terrestrial and semiterrestrial organisms are expected to vary considerably among species because of differences in feeding behavior, habitat

1 preferences, and other factors affecting exposure. Because of this variability,
2 indicator species will be selected as part of the exposure assessment to best represent
3 the species of terrestrial and semiterrestrial and wildlife potentially exposed to site-
4 related contamination.

5 Based on COPC concentration data, exposure concentrations will be estimated for
6 aquatic, semiterrestrial, and terrestrial organisms identified as potential receptors.
7 If sufficient information exists, integrated exposure analyses will be performed by
8 modeling exposure information (e.g., populations exposed, duration and frequency
9 of exposure, and routes of exposure) to calculate quantitative estimates of exposure
10 concentrations for representative receptor species.

11 To evaluate exposure to aquatic organisms, the measured concentrations of site-
12 related chemicals in surface water and sediment will serve as representative exposure
13 point concentrations. Average and maximum values will be used to represent chronic
14 and acute exposures, respectively.

15 The process of assessing terrestrial and semiterrestrial ecological exposure will
16 involve estimating the likely dosage for each relevant route, and summing these
17 estimates to derive an expected total body dosage for each receptor type. The
18 amount of exposure will depend on various factors such as the type of food
19 consumed, feeding rates, habitat preference, and home range. Indicator species will
20 be chosen to best characterize the organisms and trophic levels potentially at risk due
21 to selected exposure pathology (e.g., incidental ingestion of soil and consumption of
22 contaminated prey). It is assumed that each species chosen will be representative of
23 other species at a similar trophic position. The documentation of exposure
24 parameters for each representative species will be presented in tabular form.

25 **20.2.4 Ecological Effects Assessment**

26 In the Ecological Effects Assessment, the hazards associated with the COPCs will be
27 described, and the relationship between the concentration to which an organism is
28 exposed and the potential for adverse effects will be evaluated. Toxicological effects
29 will be evaluated using concentration-response data for acute and chronic toxic
30 effects on aquatic biota and terrestrial wildlife. The concentration-response data will
31 be used in conjunction with the exposure assessment information to develop
32 Reference Toxicity Values (RTVs) for each COPC. RTVs represent threshold
33 concentrations or doses for effects to aquatic and terrestrial organisms.

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1 Toxicity to Terrestrial Receptors. Toxicity data for terrestrial receptors will be
2 derived from acute and chronic ingestion studies. Based on these data, RTVs will
3 be developed to represent threshold concentrations below which effects would not
4 be expected. The most appropriate value for each representative species will be
5 selected as the RTV.

6 Toxicity to Aquatic Receptors. Criteria available to evaluate the toxicity of COPCs
7 in surface water include federal Ambient Water Quality Criteria (AWQC), NJDEP
8 Surface Water Quality Standards (SWQS) laboratory-derived toxicity data, and
9 threshold values developed using extrapolation techniques. These sources will be
10 used to generate RTVs for the COPCs in surface water.

11 If AWQC are not available for certain chemicals, USEPA Lowest Observable Effect
12 Levels (LOELs) will be used. The water quality standards of the Pinelands
13 Comprehensive Management Plan will also be used, if appropriate.

14 For certain chemicals, toxicity data may be available only from acute studies. To
15 develop a chronic RTV for these chemicals, a Quantitative Structure Activity
16 Relationship (QSAR) model or other appropriate reference will be used to estimate
17 an RTV.

18 Sediment Quality Criteria (SQC) will be used to evaluate the effects of sediment
19 COPCs on aquatic life. The USEPA Interim Sediment Criteria Values for Nonpolar
20 Hydrophobic Organic Contaminants (1988) and NJDEP's Guidance For Sediment
21 Quality Evaluations (1991) will be sources of sediment criteria. Following the
22 equilibrium-partitioning approach upon which these criteria are based, SQC values
23 will be calculated taking into account the TOC content of the sediment.

24 If neither USEPA Interim Sediment Criteria Values nor NJDEP criteria are
25 available for certain COPCs, the appropriateness of either the National
26 Oceanographic and Atmospheric Administration (NOAA) Sediment Threshold
27 Values and the New York State Department of Environmental Conservation
28 (NYSDEC) SQC will be evaluated.

20.2.5 Ecological Risk Characterization

29 The purpose of the Ecological Risk Characterization will be to combine the results
30 of the exposure and effects assessments to characterize the risks at the 13 Sites from
31 environmental contamination. This section will identify ecological receptors that

1 might be at risk from site-related contamination. Screening of risk will be done
2 through the use of an HI approach.

3
4 The estimated doses or exposure concentrations will be compared to RTVs.
5 Comparison of the average and maximum concentrations of chemicals detected in
6 surface water and sediment with RTVs for aquatic organisms provides a means of
7 evaluating the potential for adverse effects. Hazard Quotients (HQs) will be
8 calculated by dividing exposure concentrations by RTVs. For terrestrial receptors,
9 HQs will be calculated by dividing estimated body doses by RTVs. Cumulative HIs
10 will be calculated by summing the HQs for individual chemicals. If the cumulative
11 HI is greater than one, effects to organisms may be possible.

12
13 The Ecological Risk Characterization will include a discussion of visual observations
14 of any ecosystem degradation or other symptoms of environmental stress observed
15 during the site visit.

16
17 The findings of the Ecological Risk Characterization will be used to assess the need
18 (if any) for additional biological work, such as tissue analyses, bioassays, or a benthic
19 community ecology survey. This approach is consistent with both USEPA and
20 NJDEP guidance that advocates a tiered process for evaluating ecological risks. For
21 the 13 Sites, the need for additional biological investigations will be based largely on
22 the results of the Ecological Risk Characterization.

23
24 **20.2.6 Uncertainty Analysis**

25
26 Because the prediction of ecological risks involves several assumptions, a discussion
27 of uncertainties will be included in this section. This section will discuss both
28 site-specific uncertainties at the 13 Sites and general uncertainties inherent in the risk
29 assessment process.

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1 **21.0 PRELIMINARY IDENTIFICATION OF POTENTIAL APPLICABLE OR**
2 **RELEVANT AND APPROPRIATE REQUIREMENTS**

3
4 **21.1 INTRODUCTION**

5
6 In this section, Applicable, or Relevant and Appropriate, Requirements (ARARs)
7 and other criteria or guidelines TBC are discussed. These criteria serve two purposes
8 for the RI: (1) to aid in assessing the significance of the chemical results obtained
9 in the RI, and (2) to aid in the selection of contaminants of concern for the Risk
10 Assessment. In the FS, these criteria will be used to determine cleanup goals for
11 remedial actions.

12 **21.1.1 Definition of ARARs and Other Requirements to be Considered**

13 Section 121 (d) of CERCLA, as amended by the Superfund Amendments and
14 Reauthorization Act (SARA), requires that remedial actions comply with any
15 standard, requirement, criterion, or limitation of federal or more stringent state
16 environmental statutes. These standards, referred to as ARARs, include the statutory
17 requirements of the National Primary and Secondary Drinking Water Regulation,
18 Clean Air Act, Clean Water Act (CWA), Resource Conservation and Recovery Act
19 (RCRA), Toxic Substances Control Act (TSCA) and the Solid Waste Disposal Act,
20 among others. In accordance with the National Contingency Plan, a requirement
21 may be either applicable, or relevant and appropriate, to a remedial action, but not
22 both. These terms are discussed in the following paragraphs.

23 Applicable Requirements - Applicable requirements are those cleanup standards,
24 standards of control, and other substantive environmental protection requirements,
25 criteria, or limitations promulgated under federal or state laws that specifically
26 address a hazardous substance, pollutant, contaminant, remedial action, location, or
27 other circumstance at a site. An example of an applicable requirement is the use of
28 the Safe Drinking Water Act (SDWA) MCLs for a site where groundwater
29 contamination has affected a public water supply.

30 Relevant and Appropriate Requirements - Relevant and appropriate requirements
31 are federal and state standards, criteria, or limitations that are not legally applicable
32 to a site, but which address problems or situations sufficiently similar that their
33 application is appropriate. There is more discretion in this determination in that it
34 is possible for only part of a requirement to be considered relevant and appropriate,

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the rest being dismissed if judged not to be relevant and appropriate in a given case. Only those state standards identified by the state in a timely manner that are more stringent than the applicable federal standard may be relevant and appropriate. For example, MCLs for drinking water would be relevant and appropriate requirements at a site where groundwater contamination could affect a potential (rather than actual) drinking water source. Relevant and appropriate requirements have the same weight and consideration as applicable requirements.

Other Requirements to be Considered. Non-promulgated federal and state guidance documents or criteria do not have the status of potential ARARs. However, where specific ARARs do not exist for a chemical or situation, or where such ARARs are not protective of public health or the environment, guidance documents or advisories may be considered in determining the necessary level of cleanup for protection of health or environment.

In accordance with CERCLA guidance for conducting an RI/FS, ARARs will be identified and evaluated throughout the RI/FS process.

21.1.2 Types of ARARs

ARARs are generally classified as chemical-specific, location-specific, and action-specific as follows:

Chemical-specific ARARs - Chemical-specific requirements generally involve health- or risk-based numerical values or methodologies for site-specific hazardous substances in various environmental media. These requirements may provide site cleanup levels, or a basis for calculating cleanup levels, for chemicals of concern in designated media. Chemical-specific ARARs may also be used to develop an acceptable level of discharge, to determine treatment and disposal requirements for a particular remedial activity, and to assess the effectiveness of a remedial alternative.

Location-specific ARARs - Location-specific requirements set restrictions established for specific substances or activities based on site-specific characteristics or location. Potential remedial actions may be restricted based on proximity to wetlands or floodplains.

Action-specific ARARs - Action-specific requirements involve design, implementation, and performance requirements that are generally technology or

1 activity-based. They are based on specific remedial activities that may be selected
2 to accomplish cleanup objectives. After remedial alternatives are developed and
3 screened, the alternatives retained for detailed analysis are evaluated relative to
4 action-specific ARARs.

5

6

7 **21.2 POTENTIAL CHEMICAL-SPECIFIC ARARS**

8

9 In this subsection, an initial list is provided of potential chemical-specific ARARs and
10 other TBCs for the environmental media that will be investigated in this task
11 (groundwater, surface water, sediment, and soil).

12

13 **ARARs for Groundwater at Ft. Dix.** ARARs for groundwater applicable to the Ft.
14 Dix RI/FS for 13 Sites include:

15

- 16 • Federal MCLs and maximum contaminant level goals (MCLGs)
17 established under the SDWA
- 18 • New Jersey Drinking Water Regulations
- 19 • New Jersey Groundwater Quality Standards
- 20 • Other health advisories or criteria, as applicable
- 21 • Comprehensive Management Plan, issued by the Pinelands
22 Commission
- 23
- 24
- 25
- 26
- 27

28 In New Jersey, groundwater cleanup standards are established to protect groundwater
29 classifications set forth under the New Jersey Ground Water Quality Standards
30 (N.J.A.C. 7:9-6). The NJDEP has established natural groundwater quality as the
31 cleanup standard for all contaminants in Class IA and I-Pinelands (Preservation
32 Area) groundwater, which includes all groundwater at Ft. Dix. The numerical
33 criterion for any organic contaminant discovered at a contaminated site that is not
34 the result of natural processes is zero. Because zero can only be measured with a
35 certain degree of certainty, the Practical Quantitation Levels (PQLs) for groundwater
36 have been selected for use in establishing whether organic contaminant
37 concentrations observed in groundwater meet ARARs. Federal and state ARARs
38 for groundwater are shown in Table 11.

39

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For inorganics, "natural background" concentrations will be established for groundwater by means of analytical results obtained from "background" groundwater monitoring wells installed as part of the USAEC EI/AA being performed at Ft. Dix, the Background Sampling Program and from published regional background data. The range of values observed for inorganic constituents will be considered the natural range of concentrations expected for that constituent in groundwater. Analytical results greater than the average of the range for that constituent would be considered "above background."

ARARs and other Guidance TBC for Surface Water at Ft. Dix. For surface water, there are several ARARs:

- Federal AWQC established under the CWA
- New Jersey Surface Water Quality Standards
- Comprehensive Management Plan, issued by the Pinelands Commission

Table 12 reflects these ARARs for surface water.

New Jersey has its standard natural surface water quality for all surface water bodies in the Pinelands. The numerical criterion for any organic contaminant discovered at a contaminated site that is not the result of natural processes is zero. Because zero can only be measured with a certain degree of certainty, the PQLs for surface water have been selected for use in determining whether contaminant concentrations observed in surface water meet ARARs.

For inorganics, "natural background" concentrations will be established for surface water based on analytical results obtained from "background" surface water samples collected as part of the USAEC EI/AA, the MAG-1 Area RI, and the Background Sampling Program to be performed at Ft. Dix as well as published regional background data. The range of values observed for inorganic constituents in these samples and from published regional background data will be considered the natural range of concentrations expected for that constituent in surface water. Analytical results greater than the average of the range for that constituent would be considered "above background." These data will also be used in completion of Ecological Risk Assessments for the 13 Sites, as appropriate.

1 ARARs and Other Guidance to be Considered for Sediment at Ft. Dix. ARARs
2 include:

3

4 • Comprehensive Management Plan, issued by the Pinelands
5 Commission

6

7 The following additional guidance to be considered includes:

8

9 • Guidance for Sediment Quality Evaluations (March, 1991, New Jersey
10 Department of Environmental Protection, Division of Hazardous Site
11 Mitigation)

12

13 The Environmental Toxicology and Risk Assessment (ETRA) Section of NJDEP
14 developed the Guidance for Sediment Quality Evaluations to promote a consistent
15 methodology for determining contaminants of concern, current and potential
16 ecological impacts, and appropriate remedial activities.

17

18 Within the NJDEP's hazardous waste program, a tiered process is used in which
19 contaminant levels in sediment are initially compared against established screening
20 level criteria. When levels of contaminants exceed screening criteria, subsequent
21 evaluation is required to further characterize the magnitude of the threat posed by
22 the particular sediment to ecological resources and, where appropriate, to human
23 health (i.e., through shellfish/fish consumption). An exception to this policy can be
24 made if there is a consensus that further work is not necessary. However, adequate
25 justification must be presented to support the recommendation for no further action.
26 It is the Army's intent to follow this tiered approach, by evaluating the chemical data
27 collected from analysis of sediment samples first. Only if contaminant concentrations
28 are found to exceed screening level criteria will further investigation (in the form of
29 bioassays and/or community level bioassessment) be performed.

30

31 The guidance presents two established screening level criteria: SQC for selected
32 organic compounds, and screening level values for inorganics, and certain pesticides
33 and polynuclear aromatic hydrocarbon (PAHs).

34

35 The SQC for selected organic compounds is based on an equilibrium partitioning
36 approach (USEPA 1988, 1989c). This theoretical model is based on the partitioning
37 of nonpolar organic contaminants between sediments and interstitial waters.
38 Distribution coefficients for individual contaminants are used to establish chemical
39 concentrations in sediments that will yield concentrations in interstitial waters that

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1 are equivalent to AWQC for the protection of aquatic life. The partitioning between
2 sediments and water depends on the organic content of the sediment. Criteria have
3 been developed for both "fresh" and "saltwater." For this project, the "freshwater"
4 criteria will be used.

5 Mean, lower, and upper confidence limits have been established for the SQC for
6 each compound. The lower confidence limit represents a concentration below which
7 no adverse impacts are expected (from a particular substance) with 95 percent
8 certainty (USEPA, 1988). NJDEP suggests the use of the lower confidence limit in
9 pristine or particularly sensitive environments. Given that the classification of
10 surface water bodies under investigation is PL-Pinelands, this lower confidence limit
11 will be used. Table 13 lists the SQC for selected organic compounds.

12 Screening level values for inorganics, certain pesticides, and PAHs are found in
13 Table 14. These were taken from a summary document prepared by NOAA (1990):
14 "The Potential for Biological Effects of Sediment-sorbed Contaminants Tested in the
15 National Status and Trends Program." This report assembled and reviewed available
16 information in which estimates of the sediment concentrations of chemicals
17 associated with adverse biological effects have been established or could be derived.

18 The biological data for each compound were sorted in ascending order and two
19 values were statistically calculated; an Effects Range-Low (ER-L), a concentration
20 at the low end of the range in which effects had been observed and an Effects
21 Range-Median (ER-M), a concentration approximately midway in the range of
22 reported values associated with biological effects. In a very qualitative sense, the
23 ER-L value can be taken as a concentration above which adverse effects may begin
24 or are predicted among sensitive life stages and/or species. These criteria are
25 general values used for screening and have been biased toward saltwater systems due
26 to the nature of the data set used in the analysis.

27 In accordance with the NJDEP, the ERM value will be used in the sediment
28 screening analysis.

29 In addition, for inorganics, "natural background" concentrations will be established
30 for sediment based on analytical results obtained from "background" sediment
31 samples collected as part of the Army's EI/AA, the MAG-1 Area RI, and the
32 Background Sampling Program to be performed at Ft. Dix as well as from published
33 regional background data. The range of values observed for inorganic constituents
34 in these samples and from published regional background data will be considered the

1 natural range of concentrations expected for that constituent in sediment. Analytical
2 results greater than the average of the range for that constituent would be considered
3 "above background." These data will also be used in completion of Ecological Risk
4 Assessments for the 13 Sites as appropriate.

5

6 ARARs and Other Guidance to be Considered for Soil at Fort Dix include::

7

8 • Comprehensive Management Plan, issued by the Pinelands
9 Commission

10

11 The following additional TBC guidance also exists: The NJDEP's February 3, 1992,
12 proposed rule entitled Cleanup Standards for Contaminated Sites, N.J.A.C. 7:26D,
13 presented in Table 15 with noted corrections based upon errors identified to the
14 department during the comment period as well as new toxicological information
15 obtained since the rule proposal. Ecological impacts and other site-specific factors
16 including background conditions may result in site-specific cleanup criteria that differ
17 from the criteria listed in the table. Note that in the table there are three soil
18 cleanup criteria: residential direct contact, nonresidential direct contact, and impact
19 to groundwater. Ft. Dix is classified as non-residential with a standard industrial
20 classification of 9711. Therefore, the second and third criteria will be considered in
21 the evaluation of soil chemical data. These cleanup standards will be used as
22 screening criteria only, to be followed by a thorough risk assessment. If the risk
23 assessment results in a cleanup standard which is greater than residential direct
24 contact value, the NJDEP will require a Declaration of Environmental Restriction
25 be placed on the subject site.

26

27 In addition, for inorganics, "natural background" concentrations will be established
28 for soil based on analytical results obtained from "background" soil samples collected
29 as part of the USAEC EI/AA and Background Sampling Program to be performed
30 at Ft. Dix. The range of values observed for inorganic constituents in these samples
31 and from published regional background data will be considered the natural range
32 of concentrations expected for that constituent in soil. Analytical results greater than
33 the average of the range for that constituent would be considered "above
34 background." These data will also be used in completion of Ecological Risk
35 Assessments for the 13 Sites, as appropriate.

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21.3 POTENTIAL LOCATION-SPECIFIC AND ACTION-SPECIFIC ARARS

This subsection provides an overview of location- and action-specific ARARs that may have to be complied within the process of performing remedial activities. This list will be modified throughout the RI/FS process as new information becomes available regarding chemical data, site conditions, and potential remedial actions for the 13 Sites.

Location-specific ARARs that may limit the types of remedial actions that can be performed at a site include:

- CWA Section 404
- SDWA Section 1424(e), which confers a groundwater protective designation as the site is located within the boundaries of the New Jersey Coastal Plain Sole Source Aquifer
- New Jersey Wetlands Protection Act and Regulations
- Federal and State of New Jersey regulations concerning active fault areas and floodplains (Executive Order 11988, Floodplain Management); wilderness areas, wildlife refuges, and scenic rivers; historic sites and archaeological findings (National Historic Preservation Act 1966, as amended 16 USC 461 et seq.); and rare, threatened, or endangered species consistent with Section 7 of the Endangered Species Act of 1973 (amended 16 USC 1531)
- Protection of Wetlands Executive Order No. 11990; (40 CFR Part 6)

Action-specific ARARs are the standards or regulations associated with the remedial action selected. Examples of action-specific ARARs include surface water discharge and air emission limitations, permit requirements, and RCRA requirements on land disposal and off-site hazardous waste storage and treatment. Technology-specific ARARs will be identified as the appropriate remedial technologies for the site are identified and screened during the FS and are refined further during the Record of Decision and Proposed Plan of this investigation.

1 **22.0 HEALTH AND SAFETY**

2
3
4
5 All employees assigned to this project will receive sufficient training to recognize and
6 evaluate hazards likely to be encountered during field activities. In addition, all site
7 personnel who will be working at Ft. Dix will be medically monitored and receive
8 basic health and safety training as specified under 29 CFR 1910.120 and in the
9 Contractor Health and Safety Program Manual.

10
11 The Contractor has prepared a site-specific Health and Safety Plan, which has been
12 approved by USAEC and the Contractor's Health and Safety Manager, to address
13 foreseeable hazards associated with on-site investigations at Ft. Dix. This plan will
14 be enforced by the Health and Safety Supervisor and Site Health and Safety Officer,
15 and it includes:

16
17 a. General overview of the Contractor's Health and Safety Program;

18
19 b. Site-specific information, including proposed scope of work, site
20 history, and site health and safety risks;

21
22 c. Identification of hazardous materials likely to be encountered at the
23 site, their hazard potential, threshold, and other exposure limits;

24
25 d. Personal protective equipment requirements;

26
27 e. Monitoring equipment requirements;

28
29 f. Decontamination requirements and procedures; and

30
31 g. Emergency/contingency procedures in the event of a fire, medical
32 emergency, or other mishap/accident.

33
34 All employee and Subcontractor injuries during field efforts will be reported as per
35 Sequence No. A012, Accident/Incident Report, Data Item No. DI-A-12963. In
36 addition, an Accident Report Form will be completed for any incident involving site
 personnel or Subcontractor employees.

37
38 The Contractor is not directly responsible for Subcontractor health and safety at the
39 site. However, all Subcontractor personnel and operations will be required to abide

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1 by the requirements contained in the HASP, and the Contractor will monitor all
2 on-site operations to ensure compliance with this plan. All Subcontractors will certify
3 that their field personnel are medically monitored and trained in accordance with 29
4 CFR 1910.120. A copy of the HASP will be provided to all Subcontractors.

23.0 REMEDIAL INVESTIGATION/FEASIBILITY STUDY REPORTING

1 The environmental investigation process summarized in this Technical Plan is
2 designed to gather information at the 13 Sites at Ft. Dix to establish the nature and
3 extent of contamination, establish a Baseline Ecological Risk Assessment, and
4 develop a Human Health Evaluation to determine potential risk to human and
5 ecological receptors and the need for remedial action. Following the environmental
6 investigation, an FS will be performed that will develop, screen, and evaluate
7 remedial alternatives, and recommend a preferred alternative. The assessment of
8 this information and the methods that will be employed for reporting them are
9 described below.

10

11

12 **23.1 REMEDIAL INVESTIGATION REPORT**

13

14 This work element consists of the technical effort to prepare Draft, Draft Final, and
15 Final versions of the RI Report for the 13 Sites at Ft. Dix. The Draft Report and
16 the Draft Final Report will be subject to review by the U.S. Army and regulatory
17 agencies. No review or comment period is currently anticipated for the Final RI
18 Report. Report development consists of the drafting of text, compilation of data,
19 tables, and figures from the data evaluation activities (i.e., modeling, geologic and
20 hydrogeologic assessments, chemical analysis, Human Health Risk Assessment, and
21 Ecological Risk Assessment). Also included is a description of the field and
22 laboratory program, rationale/procedures, and assessment of data quality. Data from
23 all investigations at the 13 Sites will be summarized as part of the RI Report.

24

25 The analytical data for all media must be submitted in a summary table as follows:
26 Name of Contaminant, Location/Depth of Sampling, Date of Sampling, Date of
27 Analysis, Analytical Method, Method Detection Limit/Practical Quantitation Limit,
28 Result, Applicable Standard/Criteria (most stringent of all regulatory requirements),
29 and Exceeds Standards/Criteria. For ease of comparison the soil and sediment
30 analytical data should be reported with mg/kg until and the groundwater and surface
31 water data should be reported with µg/L unit.

32

33 **23.1.1 RI Report Organization**

34

35 As indicated in the Task Order Request, the Draft, Draft Final, and Final RI Report
36 will be developed and presented in accordance with the latest USEPA guidance,

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1 which was promulgated in interim final form in October 1988, as USEPA Office of
2 Solid Waste and Energy Response (OSWER) Directive 9335.3-01. This guidance
3 incorporates the requirements of the National Contingency Plan (NCP) as modified
4 by SARA for the conduct of the overall RI/FS process. This guidance will be used
5 for the 13 Sites at Ft. Dix.

6 At the conclusion of the RI, preliminary response objectives will be presented. These
7 objectives will be based upon the contamination assessment, risk assessment, and
8 ARARs. Summaries of these efforts are presented in this subsection. For the 13
9 Sites at Ft. Dix, one of the following recommendations will be developed in the
10 preliminary response objectives.

- 12 1. No further action is required (including remedial action). The data for
13 the site(s) is considered sufficient to rule out significant human health
14 or ecological hazards.
- 15 2. Contamination exists but no apparent migration/exposure is occurring.
16 Continue monitoring to ensure that future risks or violation of ARARs
17 does not occur.
- 18 3. Remedial action is required due to contaminant(s) releases such that
19 present or future public health risk or environmental impacts exist or
20 would be predicted. Proceed with an FS including filling any data gaps
21 as necessary (e.g., treatability, waste characterization) to select
22 appropriate remedial technology response.
- 23 4. An immediate hazard exists due to releases from a site. Prepare an
24 Action Memorandum, proceed directly to remedial design to contain/
25 mitigate or remove the hazard.

31 23.1.2 Contamination Assessment

32 The purpose of the contamination assessment is to provide a characterization of the
33 distribution of contamination, and the migration and fate of contaminants in the soil,
34 sediment, and groundwater at the 13 Sites at Ft. Dix. The contamination assessment
35 provides the interpretive link between the tabulated, validated chemical data, field
36 observations, and the interpreted hydrogeological and physical environment. This
37 information can be used to establish human health risks and environmental impacts.
38 The major outputs of the contamination assessment are the spatial distribution of
39

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1 chemical contaminants in each of the environmental media and the identification and
2 characterization of contaminant sources (qualitative and, to the extent possible,
3 quantitative). To this end, two dimensional geologic cross-sections will be prepared
4 for each site. These data will be used and reported in an assessment of contaminant
5 migration potential.

6 According to USEPA's RAGs for Superfund (December 1989), sample data can be
7 compared to background data to identify non-site-related chemicals and analytes
8 found near the site. Wherever possible, background data collected at Ft. Dix or in
9 New Jersey will be used. These data may be used in conjunction with literature and
10 historical data and data collected by the ongoing EI/AA at Ft. Dix.
11

12 Appropriate statistical techniques will be used to establish whether significant
13 site-related chemicals and analytes are present above background concentrations,
14 especially such naturally occurring chemicals as nitrates/nitrites, sulfates, and metals.
15 The particular statistical tests and methods will be chosen based upon the observed
16 distributions of chemicals and concentrations. If the data are consistent with the
17 assumptions requisite of the Gaussian (Normal) probability theory, standard
18 techniques (e.g. ANOVA, t-Tests) will be used. Otherwise, non-parametric
19 techniques may be required.
20

21 The historical chemical database that will be available for the contamination
22 assessment includes the data contained in the previous investigations at the 13 Sites
23 at Ft. Dix. These data will be reviewed, summarized, and utilized to identify the
24 source(s) and to describe the distribution of contamination. Included as an appendix
25 to the RI will be previous boring logs and well construction diagrams from the PA/SI
26 and the Phase I and Phase II RIs.
27

28 The contamination assessment element will continue after the chemical analyses of
29 soil, sediment, surface water, and groundwater samples. Groundwater samples for
30 chemical analysis will be collected from existing monitoring wells and new monitoring
31 wells. If additional samples are collected, the analyses will be included with the
32 contamination assessment. The results of groundwater samples to be collected in the
33 RI/FS will provide data for continued assessment of groundwater and possible source
34 areas. Soil, surface water, and sediment analyses at the 13 Sites at Ft. Dix will
35 provide data on current conditions contributing to groundwater contamination.
36
37

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In the contamination assessment, chemical data will be utilized from the database and anomalies identified, evaluated, and described. Data outputs from this work element will include one or more of the following:

- Depth profile and areal concentration gradient figures and/or tables
- Maps of contaminant concentrations and mass
- Chemical profiles describing the characteristics of contaminants of concern

Accompanying these data will be narrative descriptions of the spatial/temporal distribution of chemicals at each site as well as qualification and interpretation of the data and anomalies.

23.1.3 Risk Assessment

The risk assessment will include Baseline Human Health and Ecological Risk Assessments. These assessments will establish the potential risks to human and ecological receptors. The following tasks will be performed in these assessments.

The Human Health and Ecological Risk Assessments will be conducted in accordance with USEPA guidance for conducting risk assessments at Superfund Sites (RAGs Volume I [Human Health Evaluation Manual] and Volume II [Environmental Evaluation Manual] and the Superfund Exposure Assessment Manual). These assessments will also be consistent with NJDEP guidance for risk evaluation.

23.1.3.1 Human Health Risk Assessment. The Human Health Risk Assessment will begin with an identification of COPCs based on validated analytical results, site history, background conditions, and frequency of detection. The toxicity of the COPCs will be assessed. This will be followed by a human exposure assessment. The exposure assessment will include characterization of the receptor, identification of the exposure pathway, and quantification of the exposure. Finally, the human health risk characterization will be developed.

23.1.3.2 Ecological Risk Assessment. The purpose of the Ecological Risk Assessment at the 13 Sites is to provide a baseline evaluation of actual and potential risks to ecological receptors posed by chemicals in environmental media. The

1 Ecological Risk Assessment will consist of the following elements: Hazard
2 Assessment; Ecological Characterization; Ecological Exposure Assessment; Ecological
3 Effects Assessment; Ecological Risk Characterization; and an Uncertainty Analysis.
4

5 **23.1.4 ARARs**

6
7 ARARs are federal and state public health and environmental requirements and
8 guidelines that apply to hazardous waste site cleanup. Section 121 of CERCLA,
9 amended by SARA and the NCP, require that CERCLA-mandated hazardous waste
10 site remedial actions such as those in the RI program comply with federal ARARs.
11 SARA also requires attainment of state ARARs if they are more stringent than
12 federal ARARs, legally enforceable, and consistently enforced statewide. According
13 to CERCLA Section 121, the SARA requirements are applicable to remedial actions
14 at federal facilities where hazardous substances are present in the same manner that
15 they are applicable to remedial actions at non-federal facilities.
16

17 As described in the NCP, ARARs may be characterized as chemical-specific,
18 location-specific, or action-specific. Chemical-specific ARARs govern the extent of
19 site cleanup and provide either actual cleanup levels or a basis for calculating such
20 levels. Location-specific ARARs specific locations such as wetlands, floodplains, and
21 sensitive ecosystems. Action-specific ARARs are usually technology- or
22 activity-based limitations that control actions at CERCLA sites.
23

24 During the RI for the 13 Sites at Ft. Dix, both potential chemical- and
25 location-specific ARARs will be identified. Chemical-specific ARARs will consist
26 primarily of groundwater and surface water criteria and standards such as MCLs,
27 AWQC, and New Jersey State Standards. These ARARs, in conjunction with the
28 risk assessment, will be used to evaluate the extent of site cleanup.
29

30 Location-specific ARARs that may apply to the 13 Sites at Ft. Dix would include
31 state and federal wetlands requirements and endangered species lists. These ARARs
32 will provide a basis for assessing both existing site conditions and potential remedies.
33

34 Action-specific ARARs are generally identified in the FS during evaluation of the
35 remedial alternatives.
36

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23.1.5 Identification of Preliminary Remedial Action Objectives

At the conclusion of the RI, preliminary remedial action objectives will be identified. These preliminary objectives, which broadly characterize the likely extent of site cleanup, are based on the risk assessment and ARARs analyses. They provide the basis for determining the problems requiring remediation and limit the number of alternatives for consideration during the FS, when they will be developed into more detailed, target clean-up levels.

23.2 FEASIBILITY STUDY REPORT

The FS consists of three major components: development and screening of remedial alternatives, detailed evaluation of alternatives, and the FS Report.

Development and Screening of Remedial Alternatives. The FS Report will present potential federal and state public health and environmental requirements and guidelines (ARARs) used to: (1) evaluate the appropriate extent of site cleanup, (2) scope and formulate remedial action alternatives, and (3) govern the implementation and operation of the proposed action. Potential location-, chemical-, and action-specific ARARs will be listed and described in the report.

Remedial action objectives for the 13 Sites at Ft. Dix and the general response actions that may be undertaken to achieve these objectives will then be presented. Remedial action objectives are media-specific goals established to protect human health and the environment. Contaminant information from the RI Report, combined with risk assessment results and chemical-specific ARARs, will be used to develop media-specific Preliminary Remediation Goals (PRG) for each contaminant of concern.

Development and screening of remedial alternatives commences with the identification of remediation technologies capable of meeting the remedial action objectives developed as part of this work element. Identified technologies include containment, treatment, and disposal technologies capable of achieving the source control and groundwater remediation objectives. Technologies identified will include those potentially applicable to treat the historically identified site contaminants at the 13 Sites at Ft. Dix. The FS Report will contain a description of each applicable technology, technology process options, and potential site applicability. The technologies will be evaluated and screened based on waste characteristics and site

1 conditions applicability criteria and ability to meet the PRGs. A list of screened
2 technologies will be prepared.

3
4 Development and screening of alternatives will continue with the identification of
5 alternatives formulated from the screened technologies. The FS will then identify
6 and evaluate, from a technical and economic basis, the following alternatives for
7 those sites where contamination has been identified:

- 8 • no action/minimal action conditions that will be used to compare with
9 the containment, treatment, and disposal alternatives
- 10 • containment alternatives that will reduce the migration of surface and
11 subsurface soil contamination to groundwater and surface water
- 12 • treatment alternatives for contaminated soil (surface and subsurface)
13 utilizing in situ, on-site, and off-site treatment options
- 14 • disposal options for treated soil will be identified
- 15 • treatment alternatives for groundwater with and without barriers to
16 prevent contaminated groundwater from leaving the Ft. Dix installation
- 17 • combinations of alternatives for source removal/containment/
18 treatment and groundwater treatment will be developed
- 19 • surface water and sediment remediation alternatives for contaminants
20 identified in the unnamed tributary south of the 13 Sites at Ft. Dix

21 During the alternatives screening process, the FS will further refine the identified
22 alternatives. The alternatives will be evaluated to determine their effectiveness (e.g.,
23 ability to meet regulatory requirements and response objectives), implementability
24 (e.g., technical feasibility, for site-specific conditions, and equipment and service
25 availability), and cost (e.g., capital and operation/maintenance). Based on this
26 evaluation, a list of screened alternatives to be retained for detailed analysis will be
27 prepared.

28
29 **Detailed Evaluation of Alternatives.** The remedial alternatives remaining after
30 screening will be individually analyzed using USEPA guidance (October 1988a)
31 against the following evaluation criteria:
32

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- 1 • overall protection of human health and the environment
- 2 • compliance with ARARs
- 3 • long-term effectiveness and permanence
- 4 • reduction of toxicity, mobility, or volume
- 5 • short-term effectiveness
- 6 • implementability
- 7 • cost
- 8 • state acceptance
- 9 • community acceptance

10 Based on the detailed evaluation, the relative performance of the alternatives will be
11 compared. Upon completion of the comparative evaluation of alternatives, a
12 preferred alternative will be recommended for each site for the media of concern
13 (i.e., soil, sediment, surface water, and groundwater).

14 **FS Report.** The FS report will be prepared in accordance with the USEPA RI/FS
15 guidance (October 1988a). The FS report will contain a recommendation for a
16 preferred alternative for each media evaluated. This assessment evaluates each
17 alternative including the preferred alternatives according to impact/benefits of effects
18 on land and soil quality, water quality, air quality, threatened and endangered
19 species, cultural resources, land use, and so forth. The Draft FS Report will be
20 submitted to USAEC for comments. The revised Draft Final FS Report will be
21 prepared based on comments from USAEC and will be submitted to USEPA and
22 NJDEP for review. A Final FS Report will be prepared based upon comments
23 received. A summary of response to comments will be submitted to USAEC with
24 the Draft Final and Final FS Reports.

25 **23.3 PROPOSED PLAN AND RECORD OF DECISION**

26 A Proposed Plan (PP) and Record of Decision (ROD) addressing the various media
27 evaluated in the FS Report will be prepared for the 13 Sites at Ft. Dix.

28 The PP will summarize the remedial actions considered at the 13 Sites at Ft. Dix,
29 and presents USAEC's preliminary recommendations for remedial action, based on
30 the findings in the FS Report. The PP will: (1) identify the preferred alternative(s)
31 and describes the rationale for selection, (2) educate the public about how they can
32 participate in the remedy selection process, and (3) solicit public review and
33 comment on the alternatives being considered.

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1 The ROD will present the selected remedial action for the site, summarizing: (1)
2 risks posed by the site, (2) the remedial alternatives evaluated in the FS, and (3) a
3 comparative analysis of the alternatives against the evaluation criteria. The ROD
4 also presents the selected remedy and provides the rationale for how the remedy
5 satisfies the requirements of CERCLA and the NCP or waives those requirements.
6

7 The PP and ROD will be prepared in accordance with guidance in:
8

- 9 1. Interim Final Guidance on Preparing Superfund Decision Documents:
10 The Proposed Plan and Record of Decision (OSWER Directive
11 9355.3-02);
12
- 13 2. the NCP (40 CFR 300.430, March, 1990); and
14
- 15 3. state and/or regional guidance.

16 Additional guidance and direction for preparing the PP and ROD documents will be
17 obtained during information exchanges with USAEC and regulatory agencies. Draft,
18 Draft Final, and Final versions of both the PP and ROD documents will be
19 submitted to USAEC.
20

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GLOSSARY OF ACRONYMS AND ABBREVIATIONS

1	AA	atomic absorption
2	ABB-ES	ABB Environmental Services, Inc.
3	ADD	average daily dose
4	ARAR	Applicable or Relevant and Appropriate Requirement
5	ARDC	Armament Research Development Center
6	ASTM	American Standards and Test Methods
7	AWQC	Ambient Water Quality Criteria
8		
9	BBS	Bulletin Board System
10	bgs	below ground surface
11	BOD5	five-day biochemical oxygen demand
12	BOMARC	Boeing Michigan Army Research Center
13	BTEX	benzene, toluene, ethylbenzene, and xylene
14		
15	CAD	computer aided design
16	CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
17		
18	CO2	carbon dioxide
19	COC	chain of custody
20	COD	chemical oxygen demand
21	COPC	chemicals of potential concern
22	COR	Contracting Officer's Representative
23	CRL	Certified Reporting Limit
24	CRREL	Cold Regions Research and Engineering Laboratory
25	CSF	cancer slope factor
26	CVAA	cold vapor atomic absorption
27	CWA	Clean Water Act
28		
29	°F	degrees Fahrenheit
30	°C	degrees centigrade
31	DDD	dichlorodiphenyldichloroethane
32	DDE	dichlorodiphenyldichloroethylene
33	DDT	dichlorodiphenyltrichloroethane
34	DOD	Department of Defense
35	DOT	Department of Transportation
36	DQO	Data Quality Objective
37		
38	EA	Environmental Assessment
39	ECAO	Environmental Criteria and Assessment Office

GLOSSARY OF ABBREVIATIONS AND ACRONYMS

1	EI/AA	Environmental Investigation/Alternatives Analysis
2	ER-L	effects range-low
3	ER-M	effects range-mid
4	ESE	Environmental Science and Engineering, Inc.
5	ETRA	Environmental Toxicology and Risk Assessment
6		
7	FORSCOM	Forces Command
8	FS	feasibility study
9	Ft. Dix	Fort Dix U.S. Army Installation
10	ft/mi	feet per mile
11	FTTA	Fire Training Tank Area
12		
13	GC	gas chromatography
14	GC/ECD	gas chromatography/electron capture detector
15	GC/MS	gas chromatography/mass spectroscopy
16	GFAA	graphite furnace atomic absorption spectroscopy
17	GGS	Geotechnical Groundwater Stabilized
18	GMA	Geotechnical Map File
19	gpm	gallons per minute
20	GPR	ground penetrating radar
21		
22	HASP	Health and Safety Plan
23	HEAST	Health Effects Assessment Summary Table
24	HI	Hazard Index
25	HN03	nitric acid
26	HQ	Hazard Quotient
27	HSA	hollow-stem auger
28		
29	ICAP	inductively coupled argon emission plasma spectroscopy
30	ICUZ	Installation Compatible Use Zones
31	ID	inside diameter
32	IKW	Iffland, Kavanaugh, Waterbury
33	IR	Infrared Spectroscopy
34	IRDMIS	Installation Restoration Data Management System
35	IRIS	Integrated Risk Information System
36		
37	LADD	lifetime average daily dose
38	LNAPL	light nonaqueous phase liquids
39	LOE	level of effort

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

1	LOEL	Lowest Observable Effect Level
2	MCL	Maximum Contaminant Level
3	MCLG	maximum contaminant level goals
4	mg/kg	milligrams per kilogram (equivalent to parts per million)
5	mm	millimeter
6	MODFLOW	Modular Three-Dimensional Finite Difference Groundwater Flow Model
7	mph	miles per hour
8	MRD	Missouri River Division
9	MSL	mean sea level
10	MW	monitoring well
11	NCP	National Contingency Plan
12	NEA	New Egypt Armory Site
13	NGVD	National Geodetic Vertical Datum
14	NJAL	New Jersey Action Level
15	NJDEP	New Jersey Department of Environmental Protection
16	NOAA	National Oceanographic and Atmospheric Administration
17	NYSDEC	New York State Department of Environmental Conservation
18	OD	outside diameter
19	o,p'-DDD	2-(o-chlorophenyl)-2-(p-chlorophenyl)1,1,1-trichloroethane
20	OSWER	Office of Solid Waste and Energy Response
21	PA/SI	Preliminary Assessment/Site Investigation
22	PAH	polynuclear aromatic hydrocarbon
23	PAL	Project Analyte List
24	PCB	polychlorinated biphenyl
25	PDC	Program Data Coordinator
26	PID	photoionization detector
27	PL	Pinelands Commission
28	PP	Proposed Plan
29	ppb	parts per billion
30	POL	Petroleum, Oil, Lubricant Area
31	PQL	practical quantitation limit
32	PRG	Preliminary Remediation Goal
33	PRI	Potomac Research Institute
34	PVC	polyvinyl chloride

GLOSSARY OF ABBREVIATIONS AND ACRONYMS

1	QA	quality assurance
2	QA/QC	quality assurance/quality control
3	QAC	Quality Assurance Coordinator
4	QAPP	Quality Assurance Project Plan
5	QSAR	Quantitative Structure Activity Relationship
6		
7	RAGS	Risk Assessment Guidance for Superfund
8	RCRA	Resource Conservation and Recovery Act
9	RfC	reference concentration
10	RfD	reference dose
11	RI	remedial investigation
12	RI/FS	remedial investigation/feasibility study
13	RME	reasonable maximum exposure
14	ROD	Record of Decision
15	RTV	Reference Toxicity Value
16		
17	SARA	Superfund Amendments and Reauthorization Act
18	SC	soil boring
19	SCAPS	Site Characterization and Analysis Penetrometer System
20	SDWA	Safe Drinking Water Act
21	SE	sediment
22	SOL	Site Operations Leader
23	SQC	Sediment Quality Criteria
24	SVOC	semivolatile organic compound
25	SW	surface water
26	SWQS	Surface Water Quality Standards
27		
28	TAL	target analyte list
29	TBC	to be considered
30	TC	Terrain Conductivity
31	TCL	target compound list
32	TDS	total dissolved solids
33	TMP	Transportation Motor Pool
34	TOC	total organic carbon
35	TP	test pit
36	TPH	total petroleum hydrocarbon
37	TRADOC	U.S. Army Training and Doctrine Command
38	TSCA	Toxic Substances Control Act
39	TSS	total suspended solids

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

1	UCL	upper confidence limit
2	$\mu\text{g}/\text{L}$	micrograms per liter
3	UR	unit risk
4	USACOE-WES	United States Army Corps of Engineers - Waterways Experiment Station
5	USAEC	United States Army Environmental Center
6	USAEHA	U.S. Army Environmental Hygiene Agency
7	USATHAMA	United States Army Toxic and Hazardous Materials Agency
8	USCS	Unified Soil Classification System
9	USEPA	United States Environmental Protection Agency
10	USFWS	United States Fish and Wildlife Service
11	USGS	United States Geologic Survey
12	UST	underground storage tank
13	UTM	Universal Transverse Mercator
14	UV	Ultraviolet
15	UXO	unexploded ordnance
16	VOC	volatile organic compound
17		
18	111TCE	1,1,1-trichloroethane
19	2,4-D	2,4-dichlorophenoxyacetic acid
20	2,4-DNT	dinitrotoluene
21		
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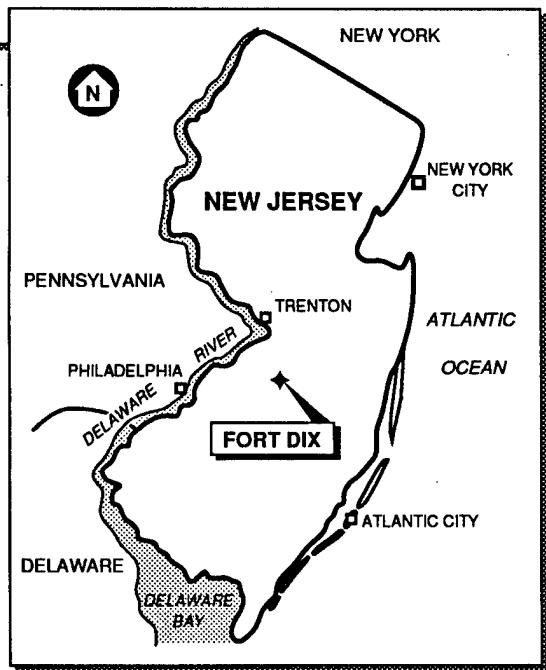
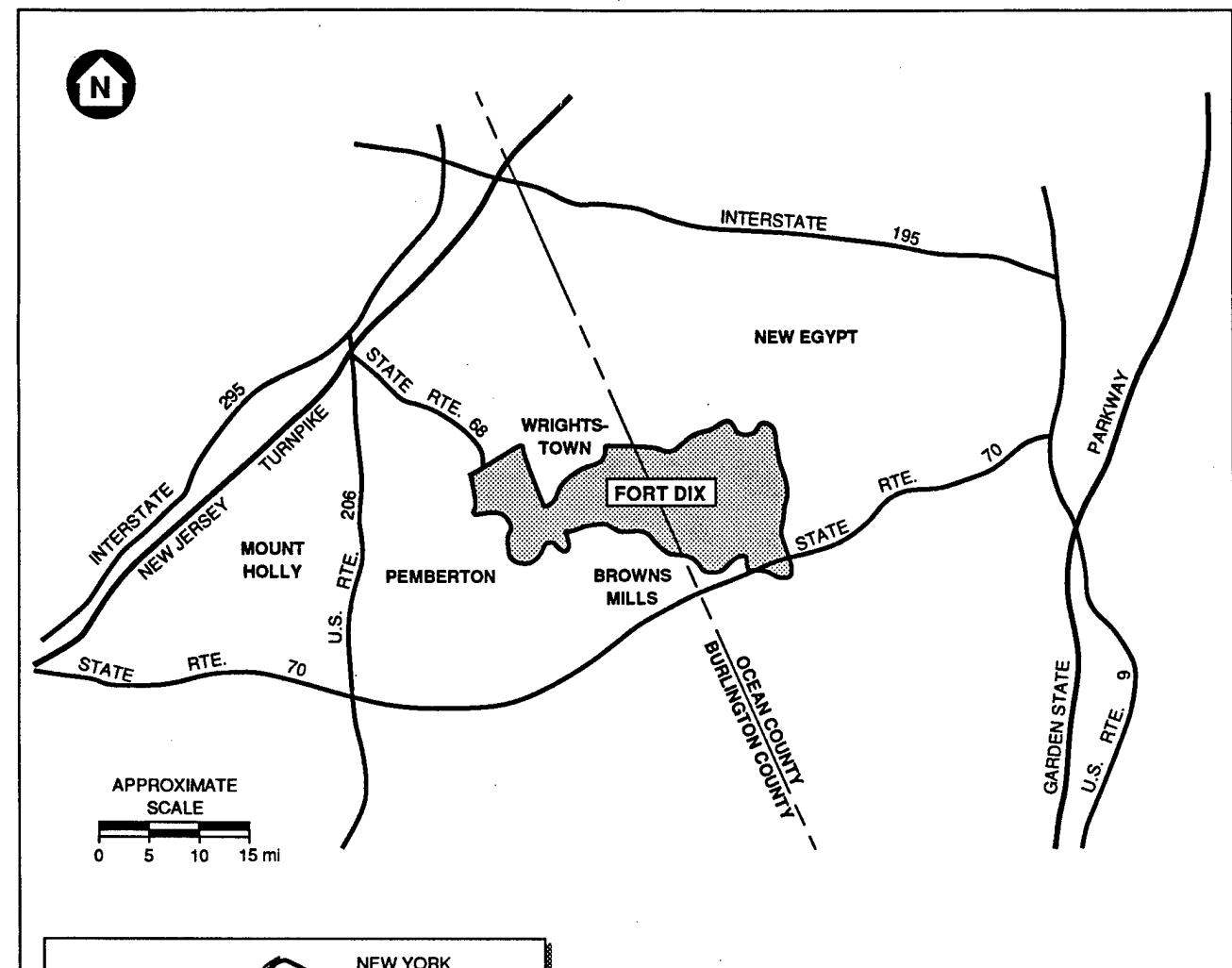
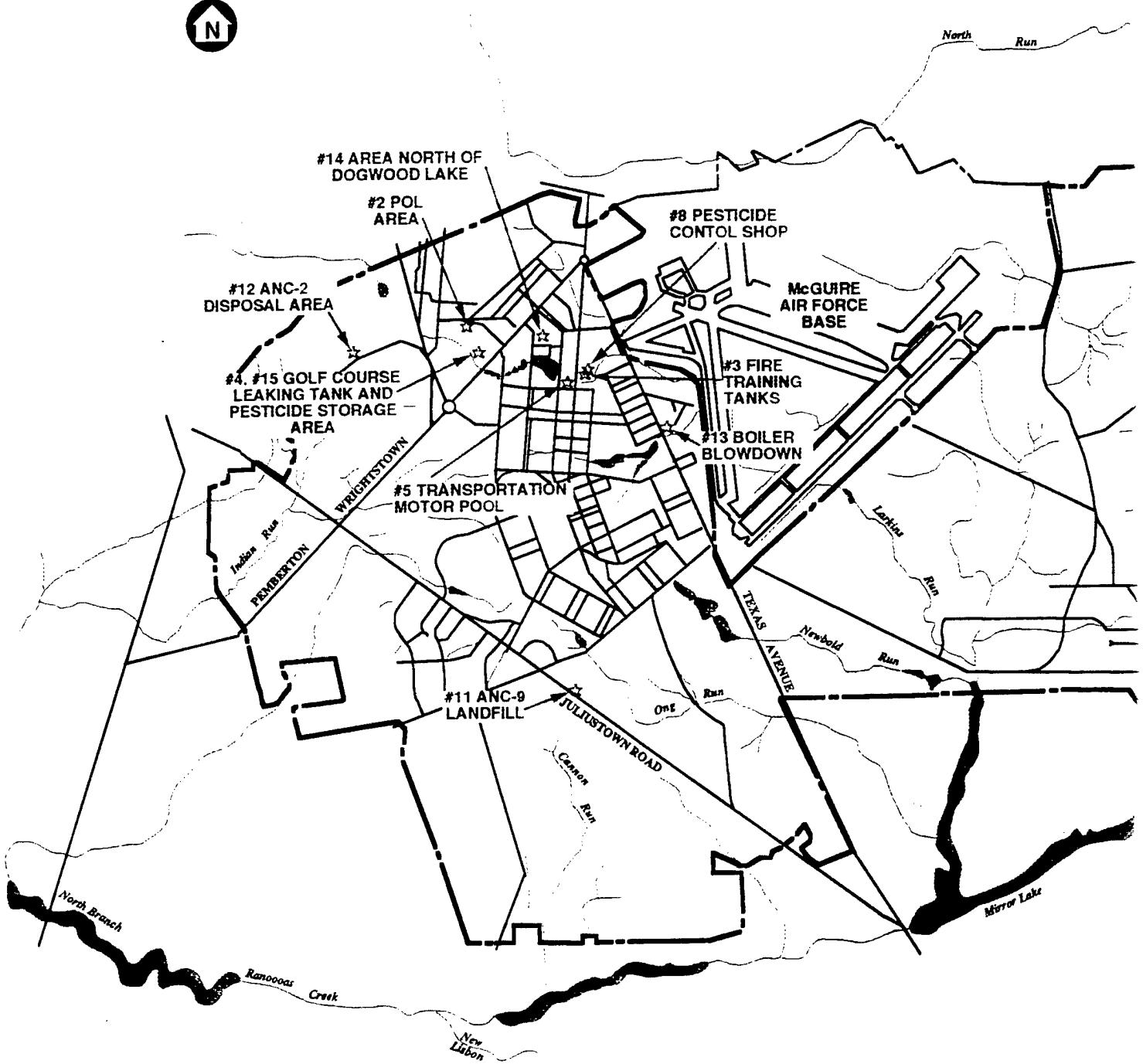


FIGURE 1
FORT DIX LOCATION MAP
TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

SOURCE: DAMES AND MOORE, 1993.



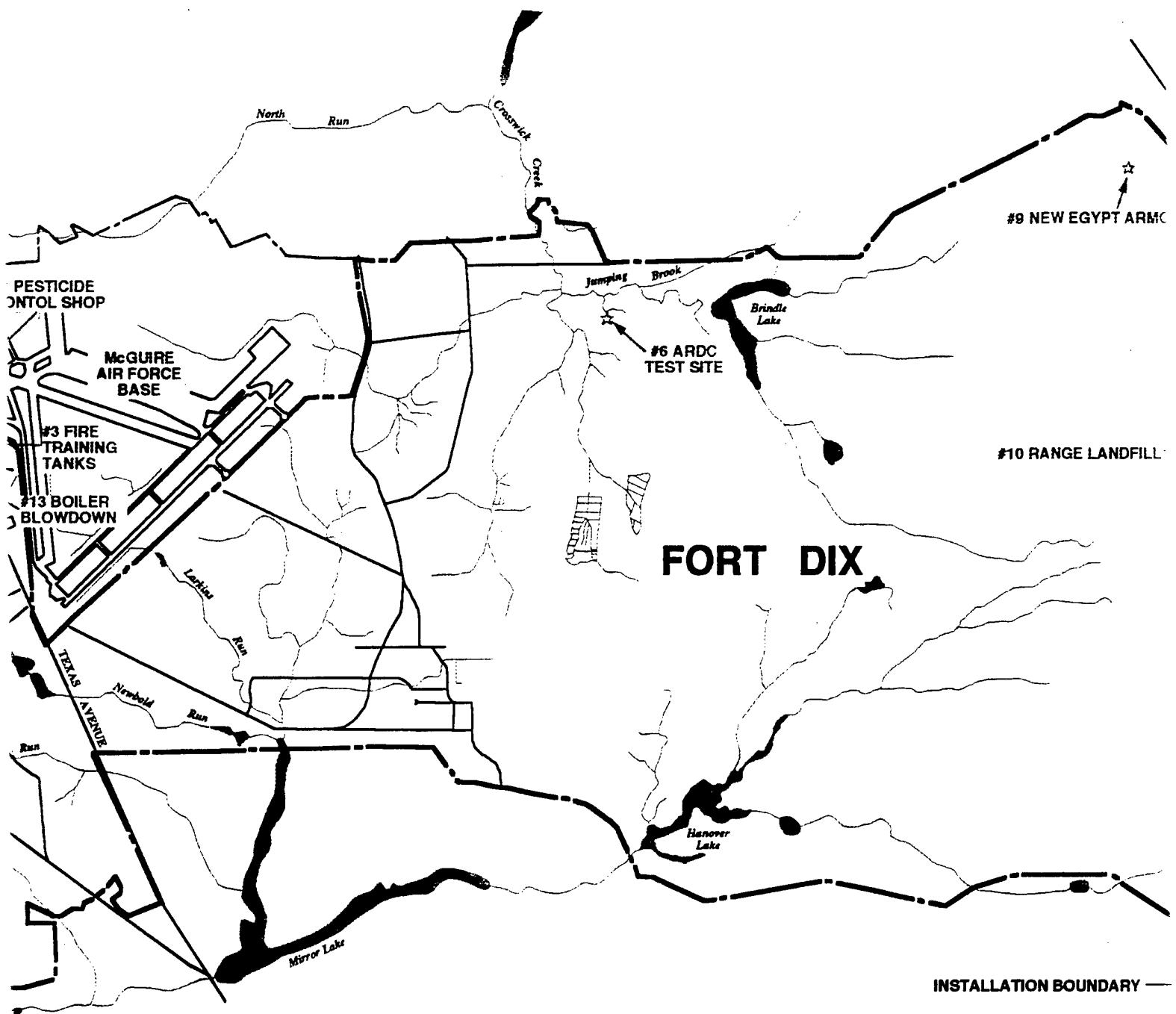
LEGEND

- ☆ LOCATION OF SITE
- STREAM
- LAKE/POND
- INSTALLATION BOUNDARY

APPROXIMATE SCALE IN FEET

0 3,000 6,000

SOURCE: ICF, 1994.



INSTALLATION BOUNDARY —

LOCATION OF 13 SITES AND

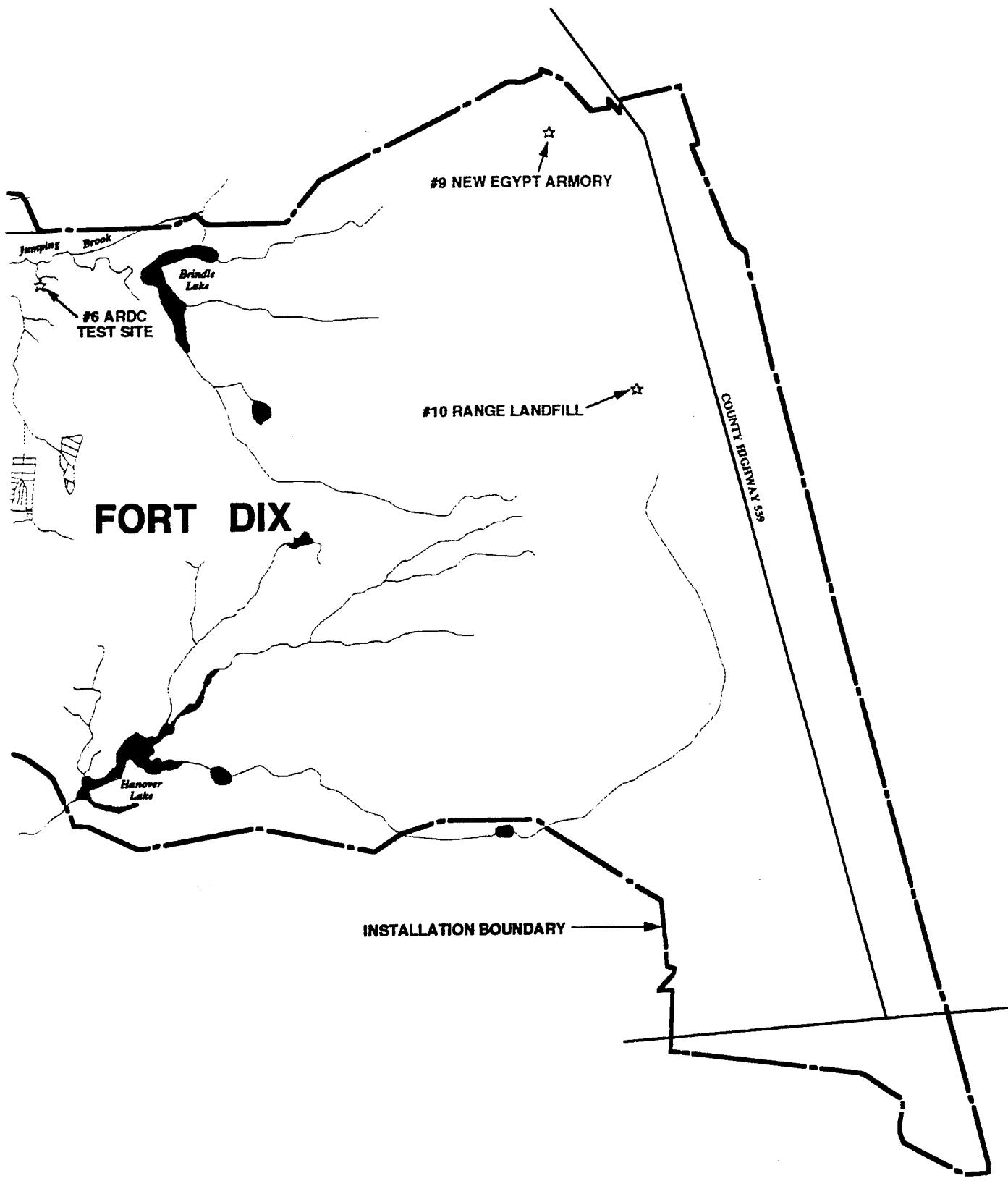


FIGURE 2
LOCATION OF 13 SITES AND WATER RESOURCE FEATURES
TECHNICAL PLAN
FORT DIX R/FS FOR 13 SITES

ABB Environmental Services, Inc. —

①

SITE 4 - GOLF COURSE LEAKING
SITE 15 - GOLF COURSE PESTICIDE
STORAGE AREA

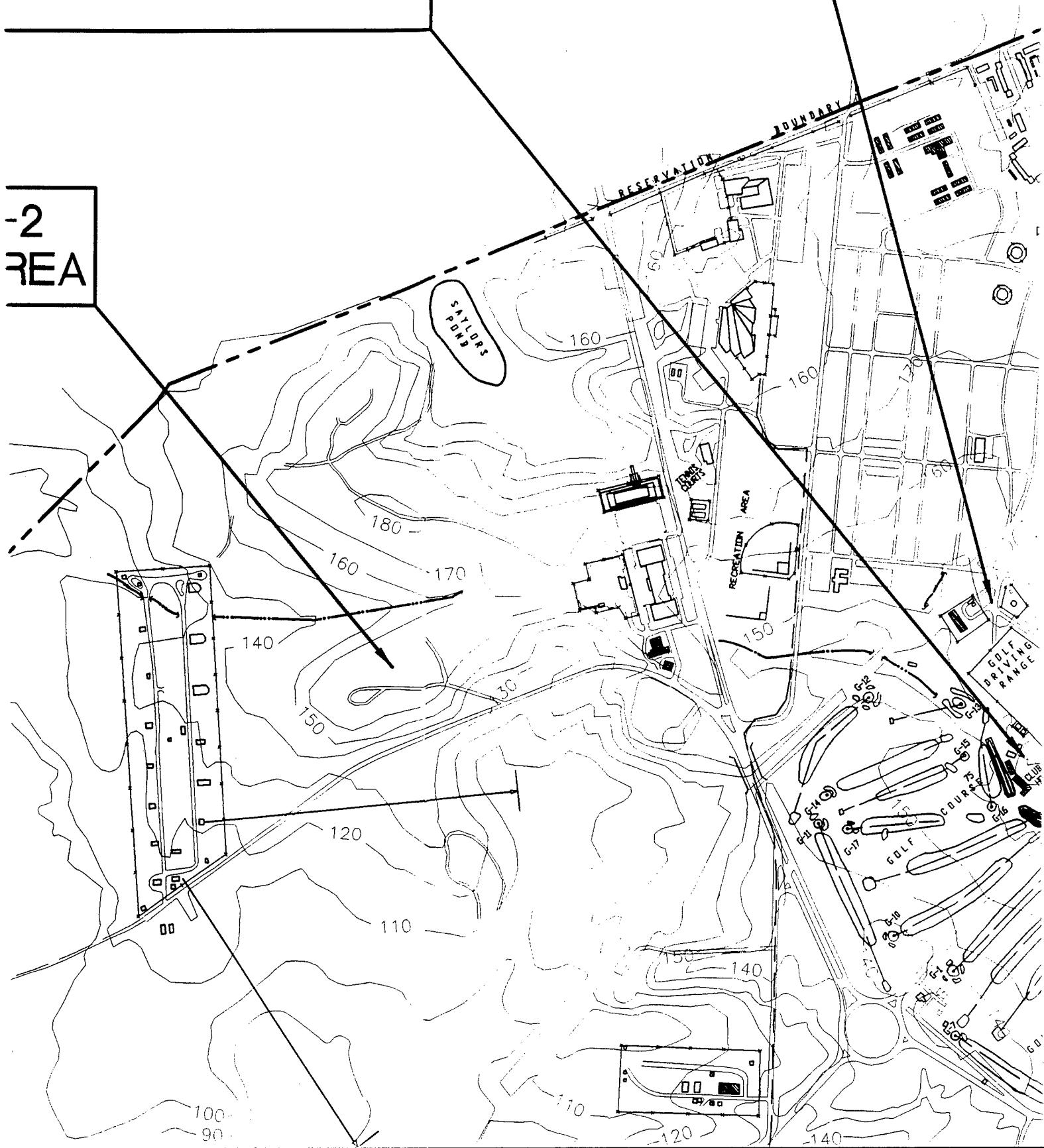


SITE 12-ANC-2
DISPOSAL AREA

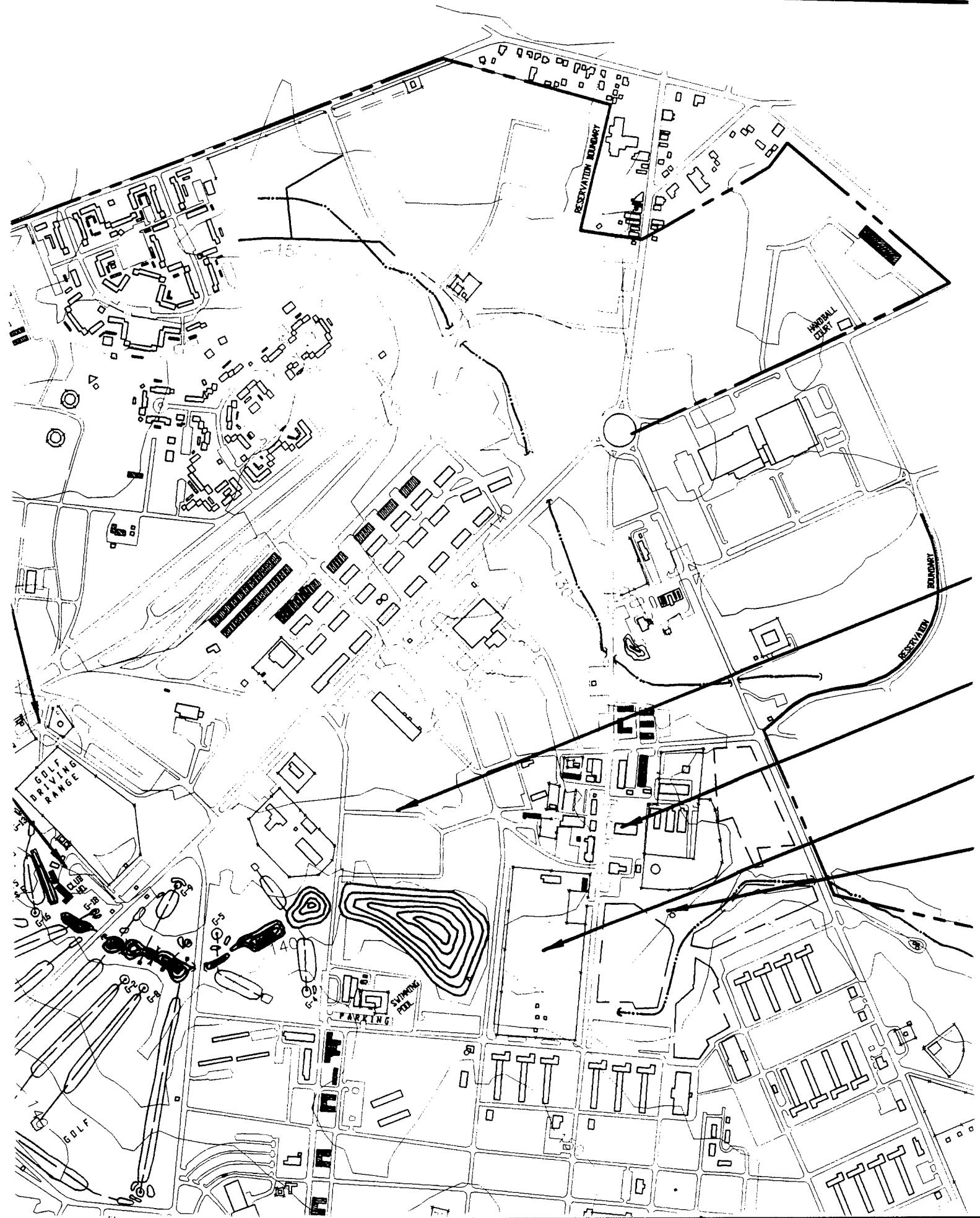


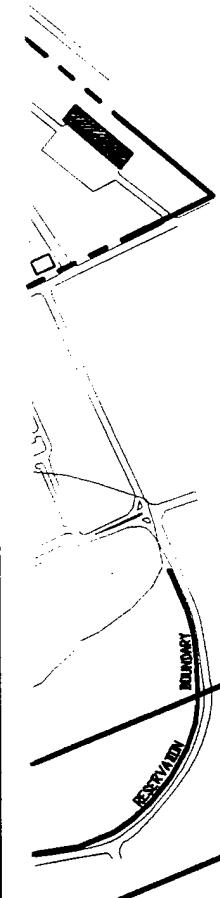
WATER TANK AREA Pesticide Mixing and

SITE 2-POL AREA



3



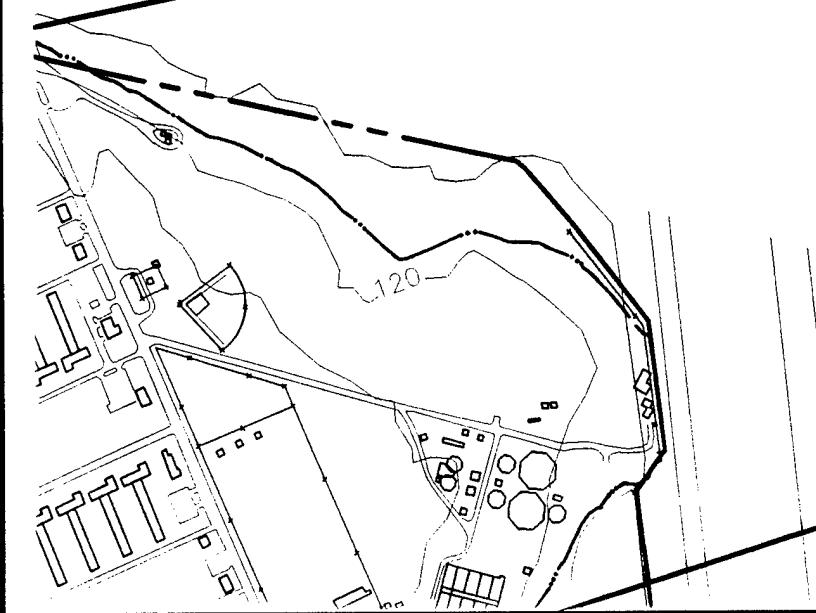


SITE 14 - AREA NORTH OF DOGWOOD

SITE 8 - PESTICIDE CONTROL SHOP

SITE 5 - TRANSPORTATION MOTOR PO

SITE 3 - FIRE TRAINING TANKS AREA



SITE 13 - BOILER BLC

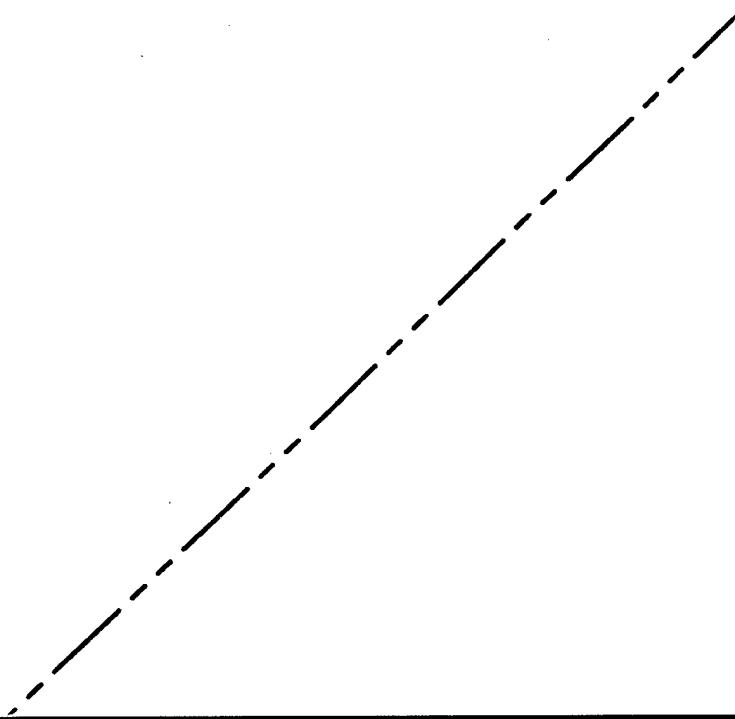
COD LAKE

CP

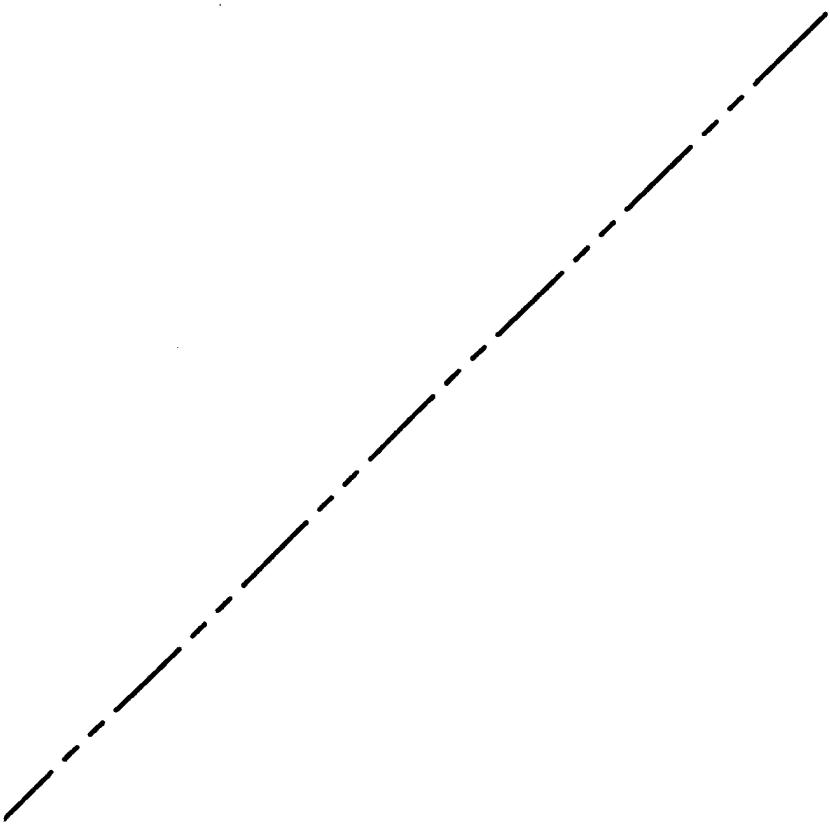
R POOL

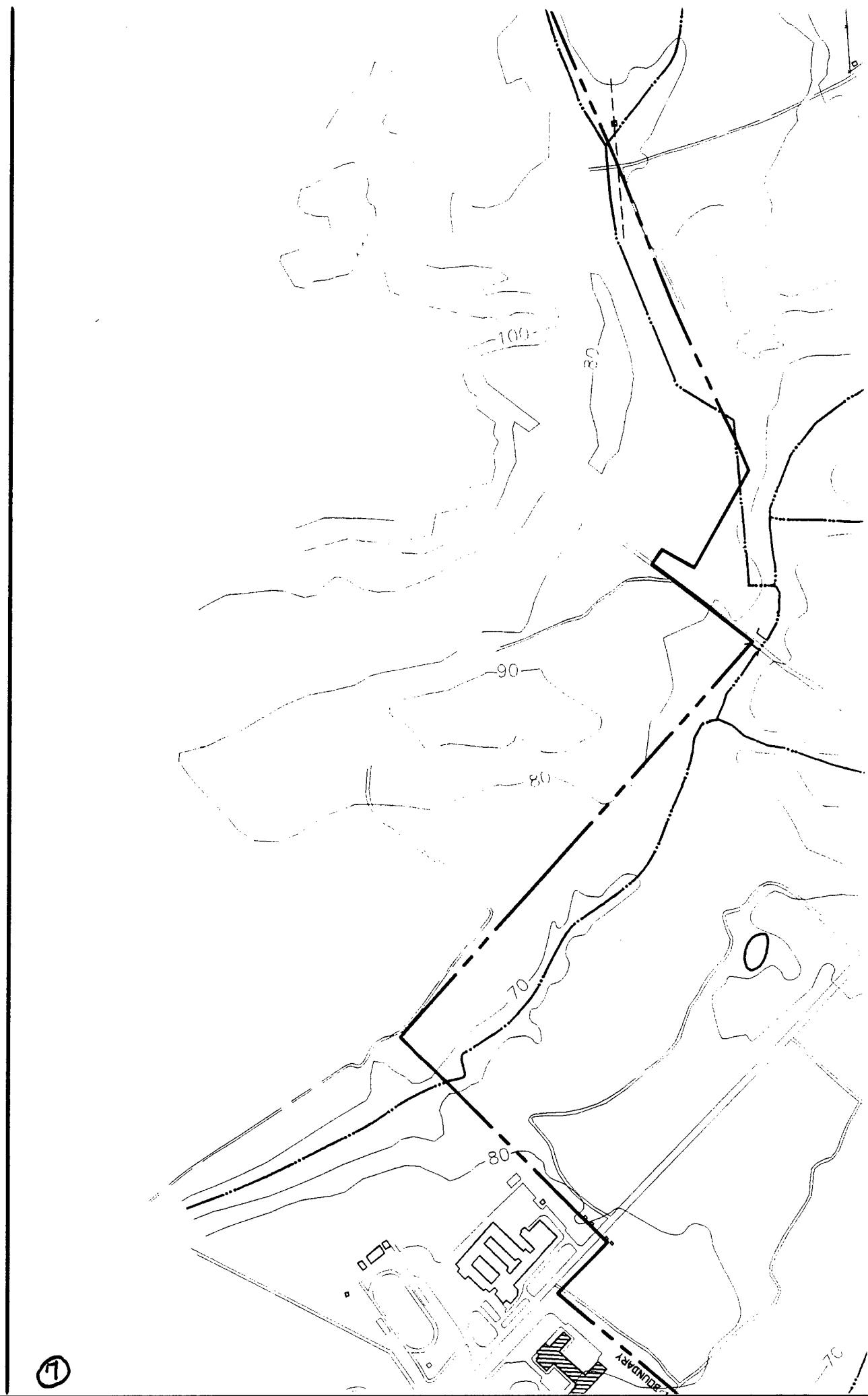
EA

R BLOWDOWN AREA

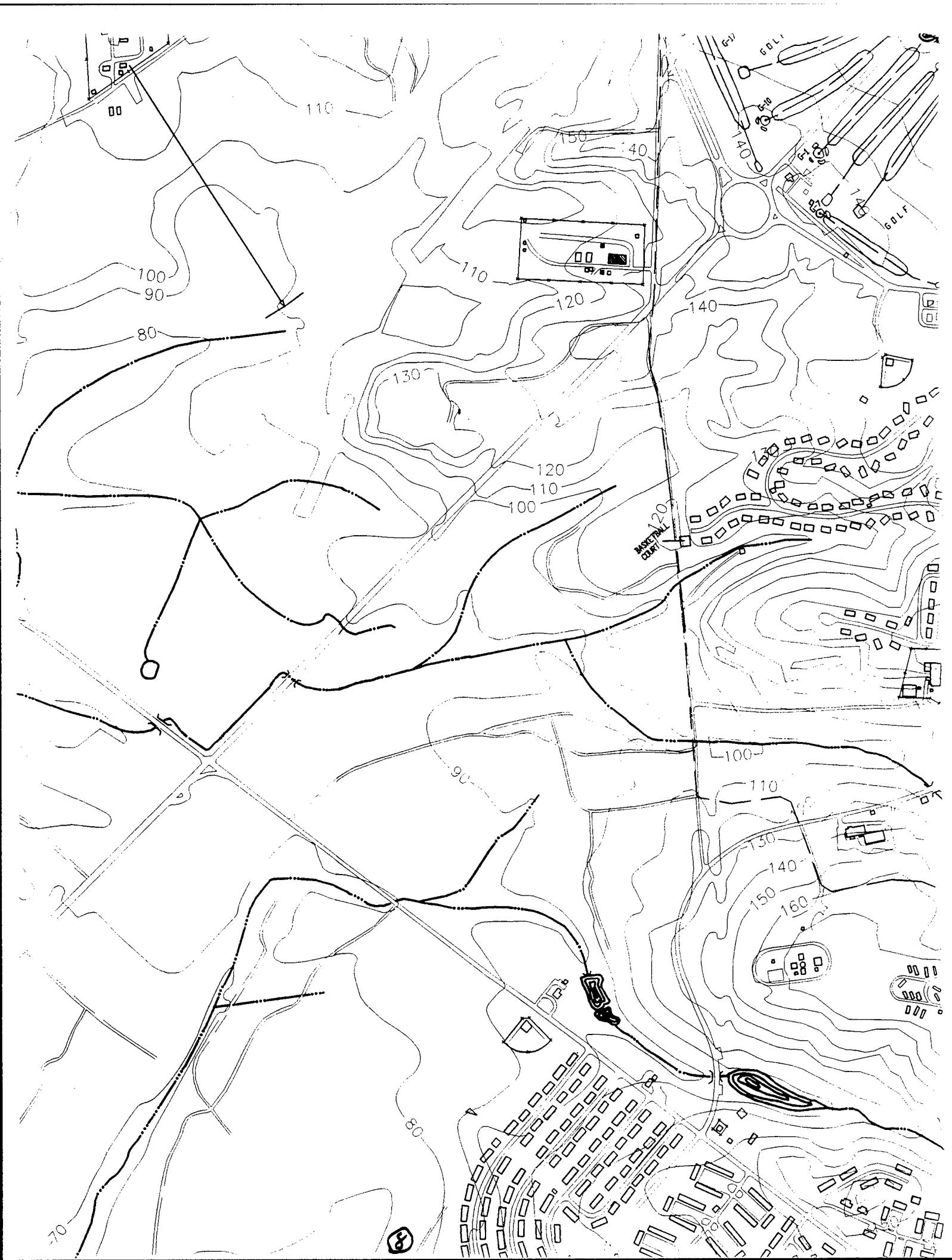


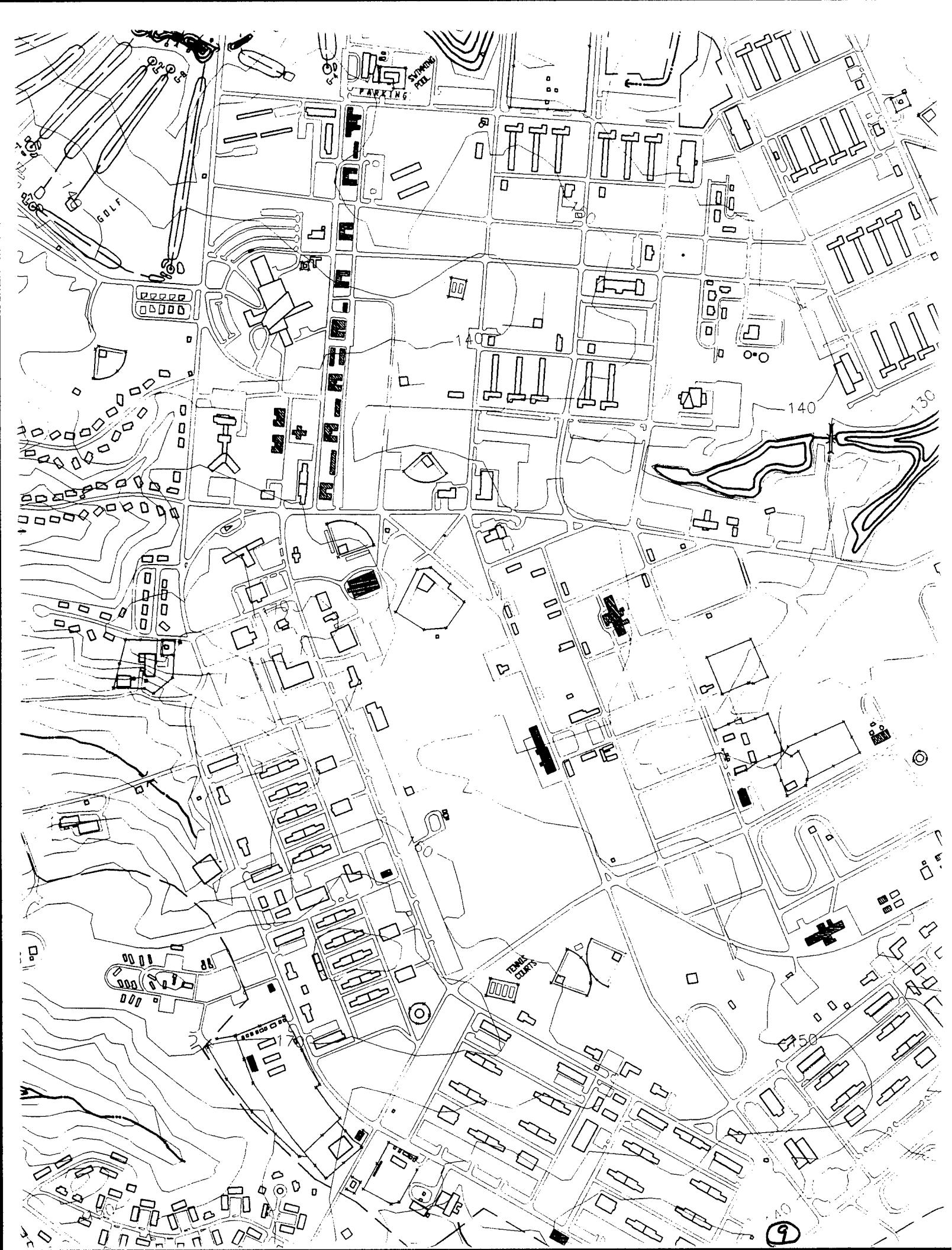
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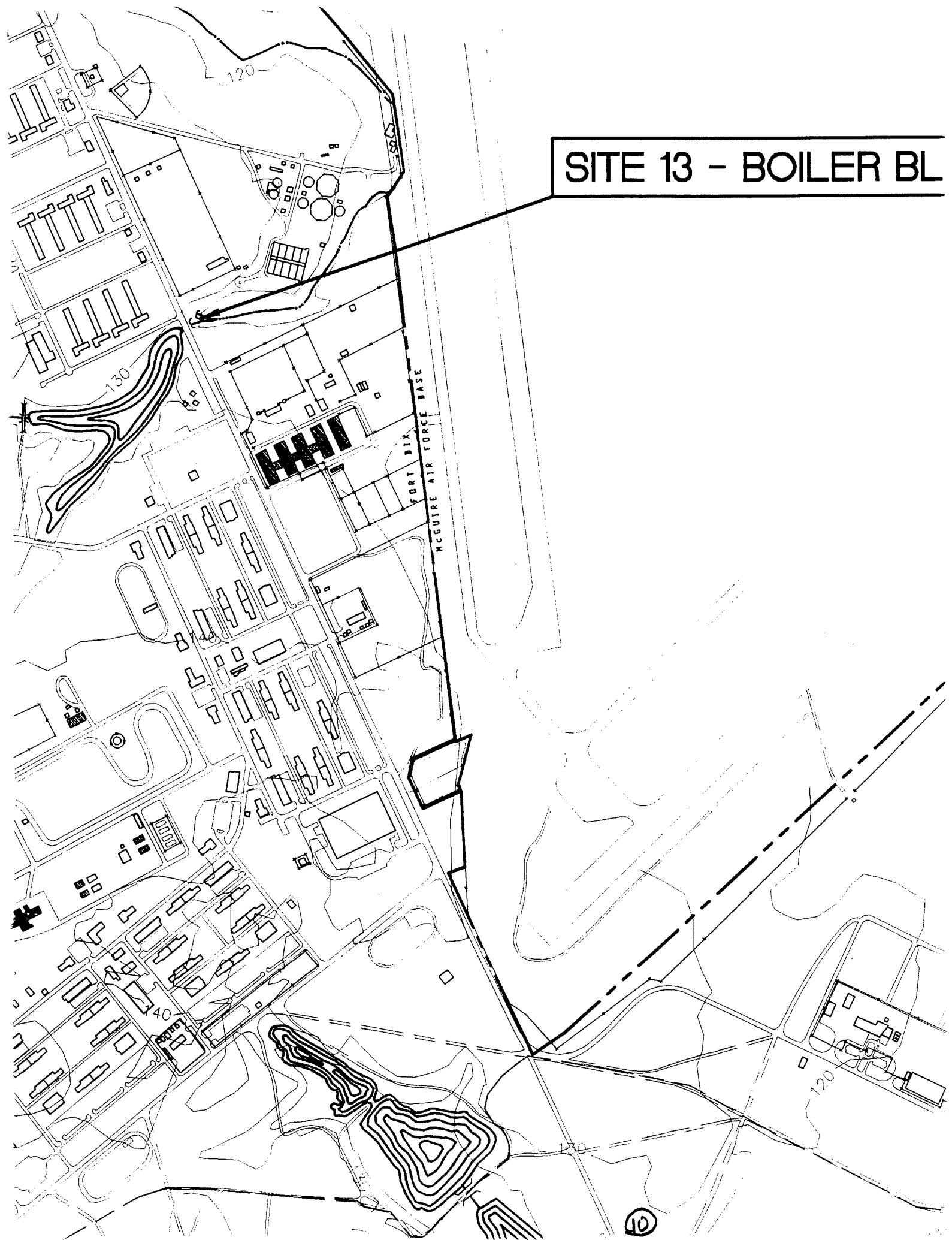


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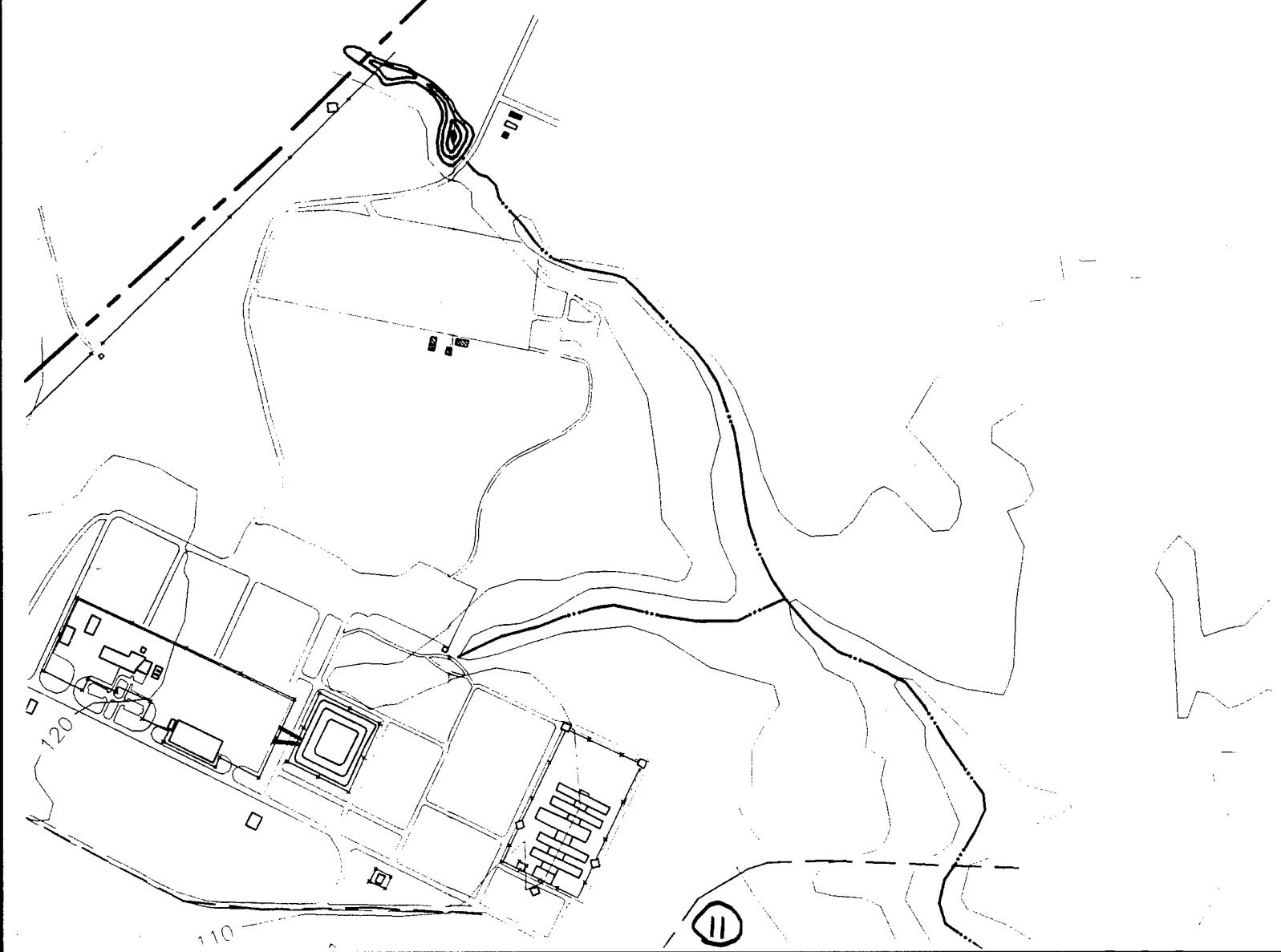


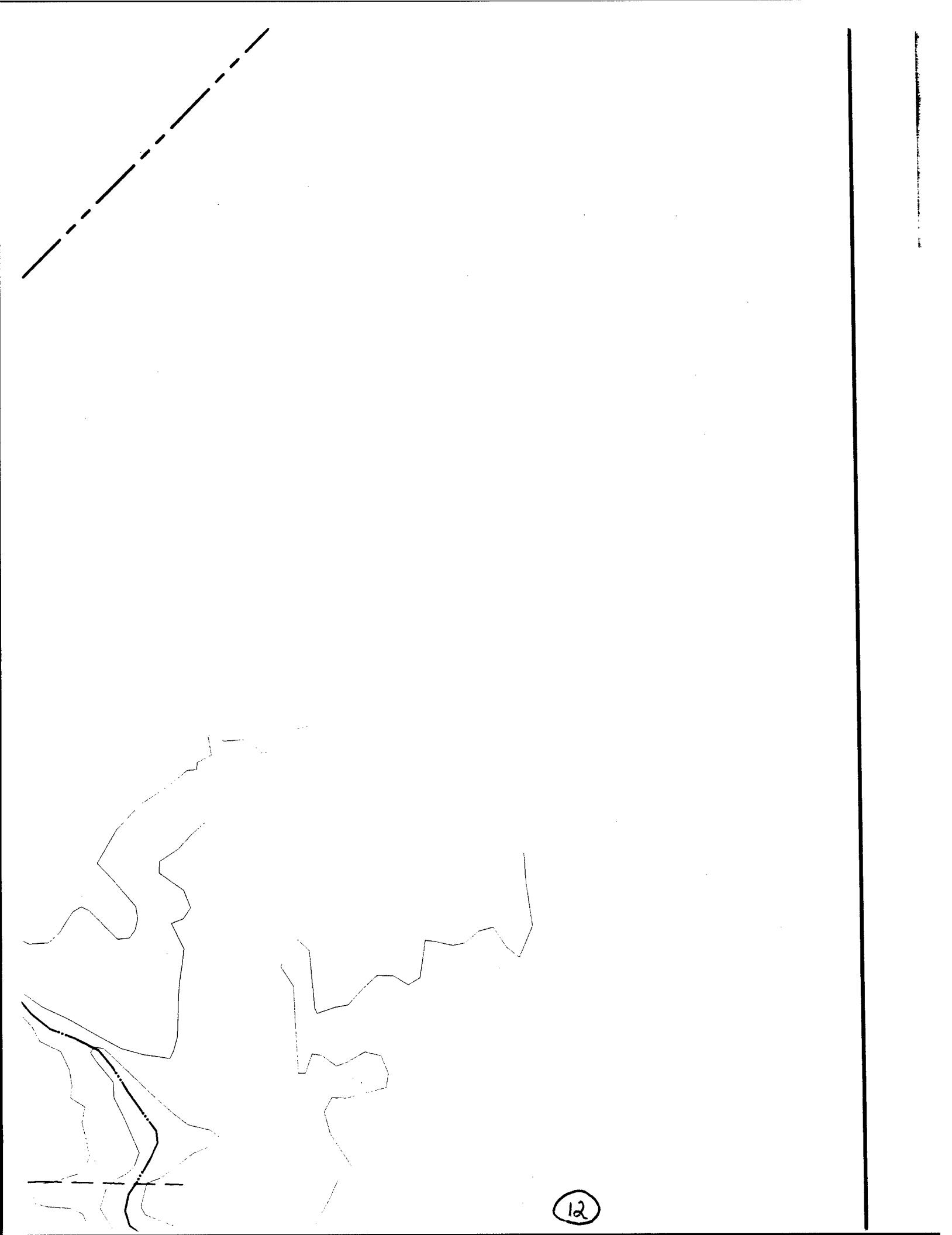


SITE 13 - BOILER BL



BOILER BLOWDOWN AREA





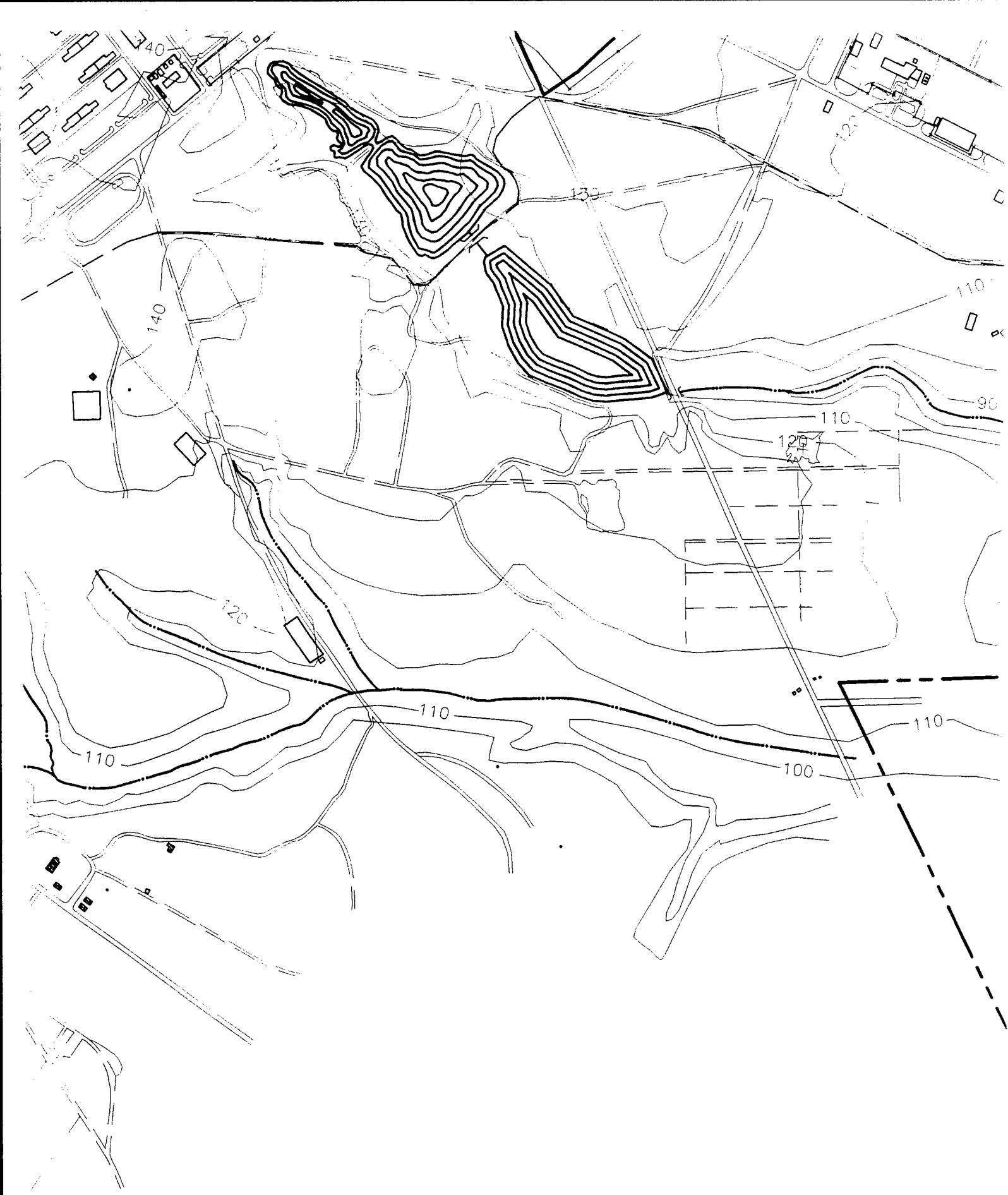
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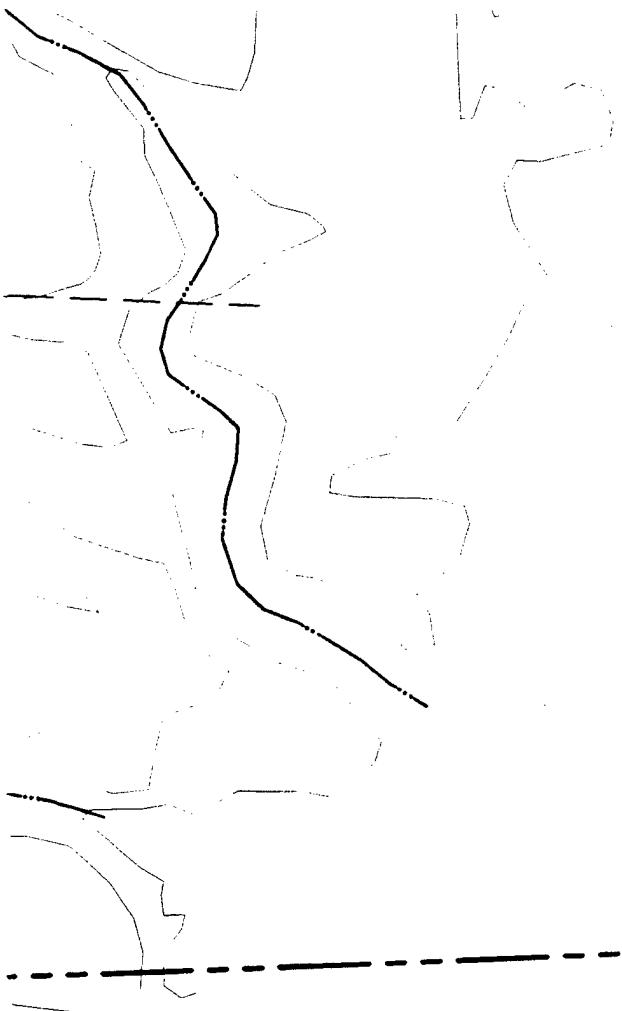
**SITE 11-ANC-9
LANDFILL**





LEGEND

- 1. CHAIN LINK FENCE
- 2. DIRT ROADS
- PAVED ROADS
- STREAM
- WATER BODIES



LEGEND

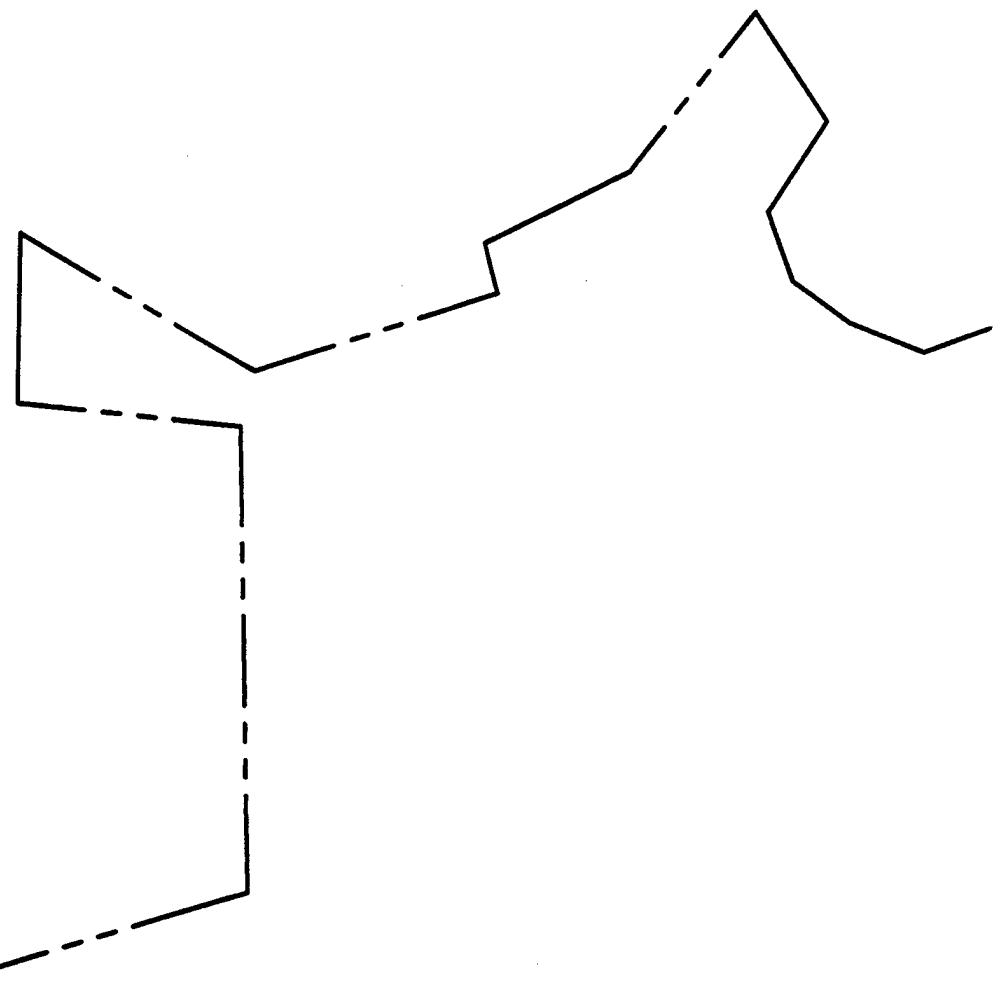
- * — CHAIN LINK FENCE
- — — DIRT ROADS
- — — PAVED ROADS
- · · — STREAM
-  WATER BODIES

NOTES:

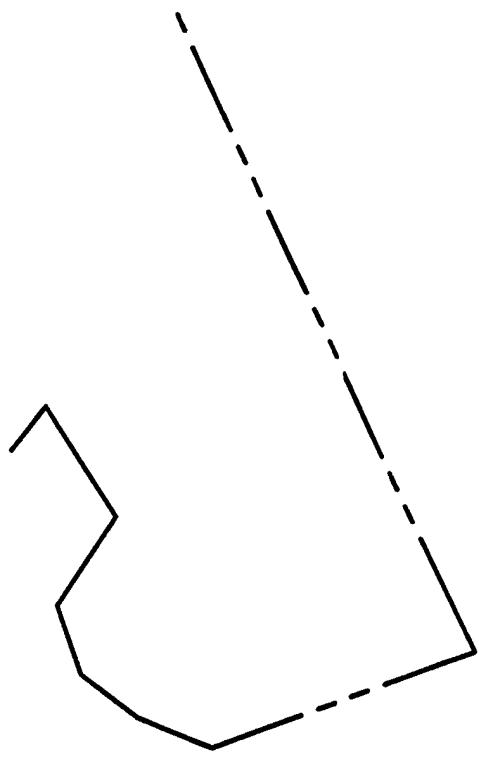
1. CAD BASE MAP SOURCE: FORT DIX
2. TOPOGRAPHIC CONTOURS DIGITIZED FROM USGS 7.5 MINUTE QUADRANGLES.

20

**SITE 11-ANC-9
LANDFILL**



22



0 400 800 1600 FEET

SCALE: 1" = 800'

**LOCATIONS
THE CANTON
FORT DIX RI/FS F
ABB Environmental**

DAVED ROAD

STREAM

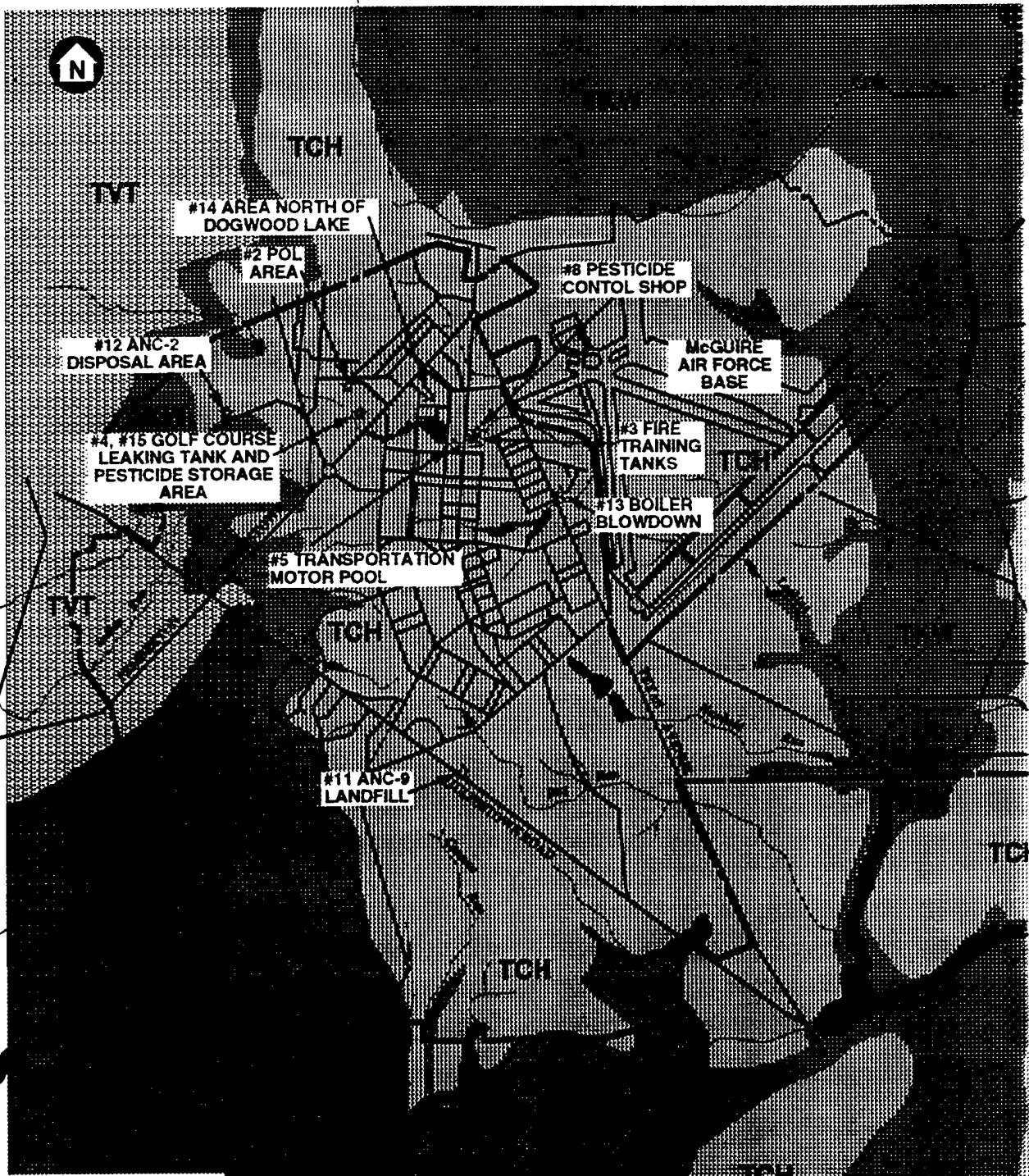


WATER BODIES

400 800 1600 FEET

SCALE: 1"=800'

FIGURE 3
LOCATIONS OF SITES IN
THE CANTONMENT AREA
FORT DIX RI/FS FOR 13 SITES
— ABB Environmental Services, Inc.



LEGEND

- ★ LOCATION OF SITE
- STREAM
- LAKE/POND
- INSTALLATION BOUNDARY

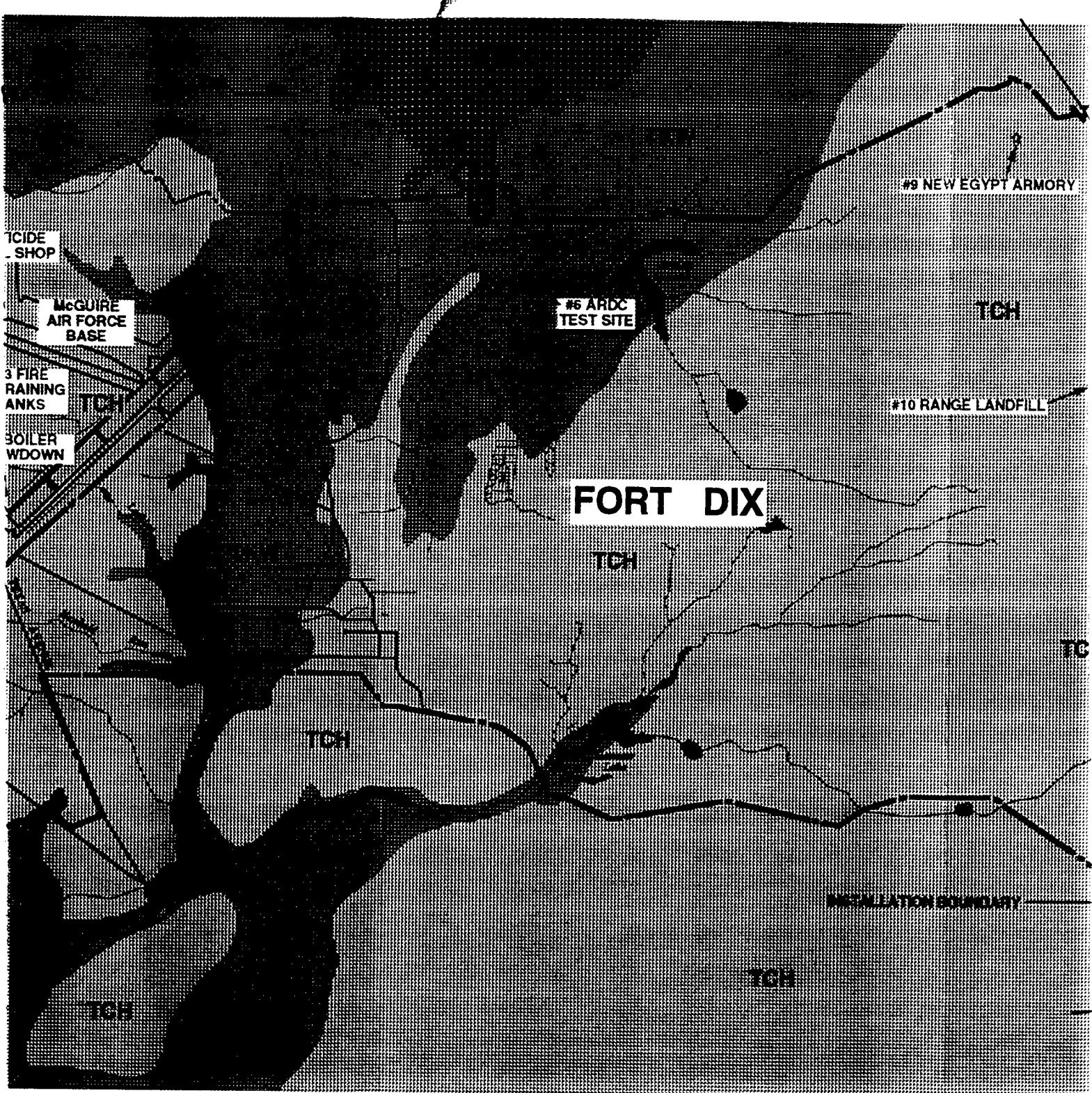
APPROXIMATE SCALE IN FEET

0 3,000 6,000

SOURCE: ICF, 1994.

Geologic Formation

■	TMQ = MANASQUAN FORMATION
■	TKW = KIRKWOOD FORMATION
■	TCH = COHANSEY SAND
■	TVT = VINCENTOWN FORMATION



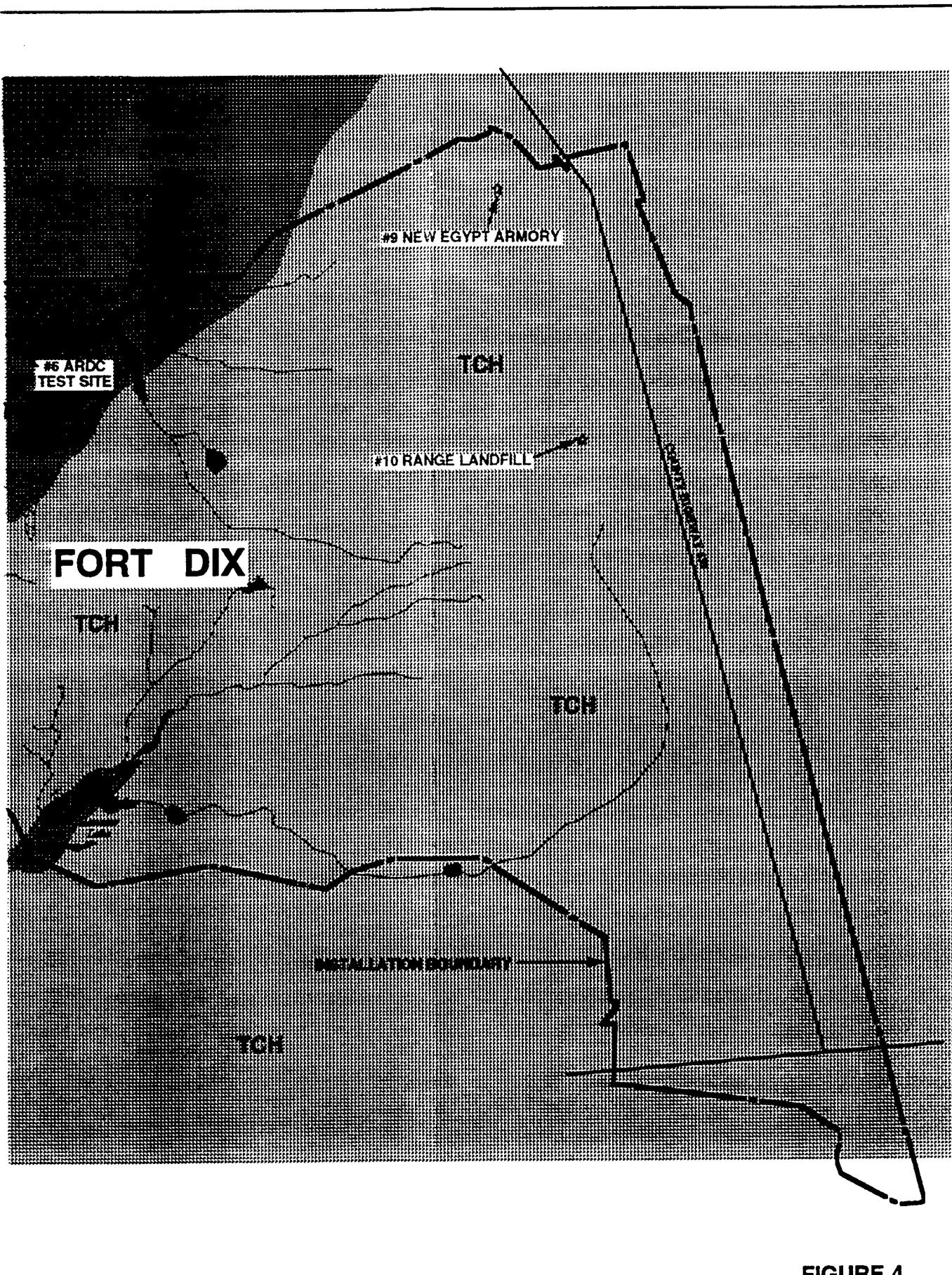
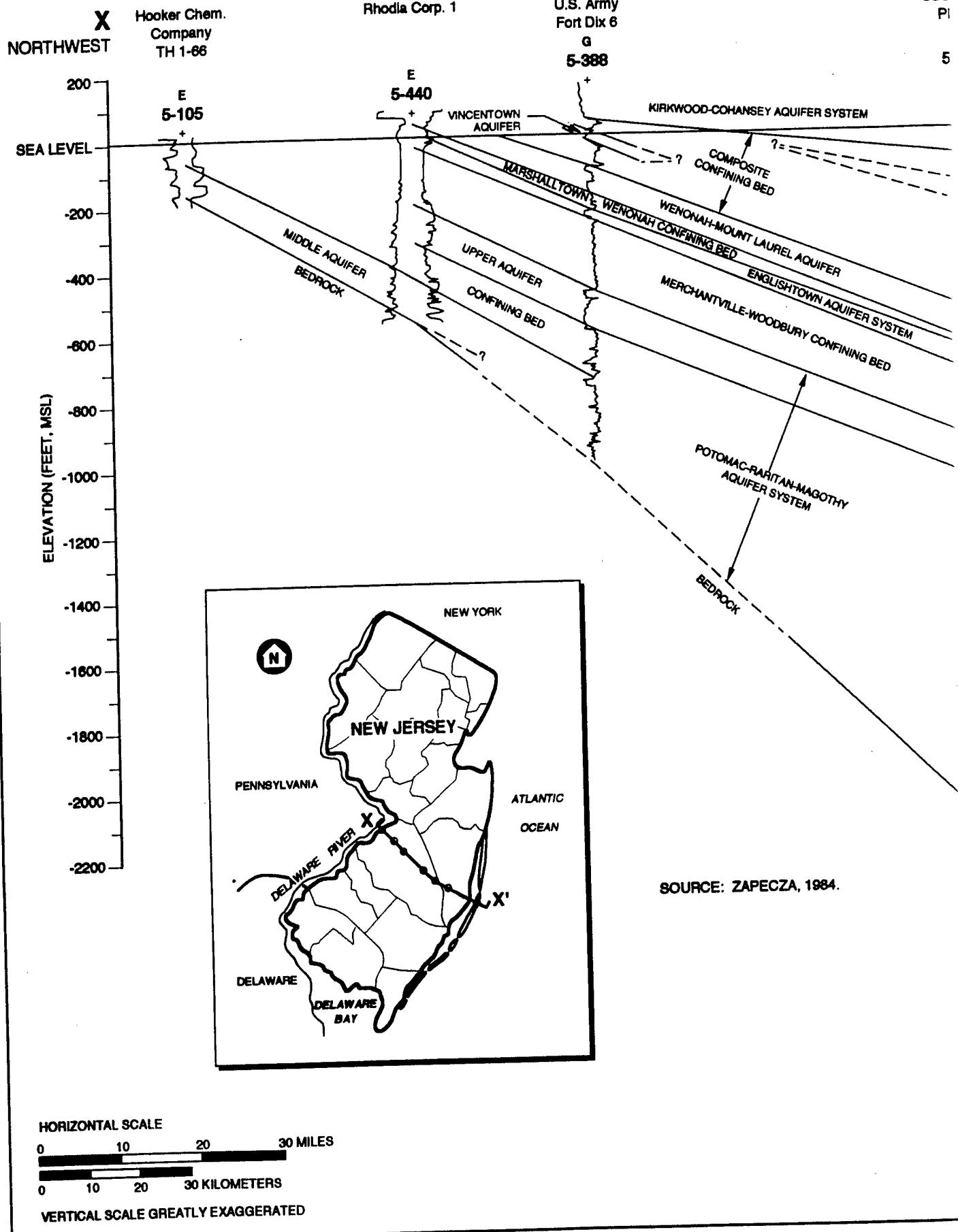
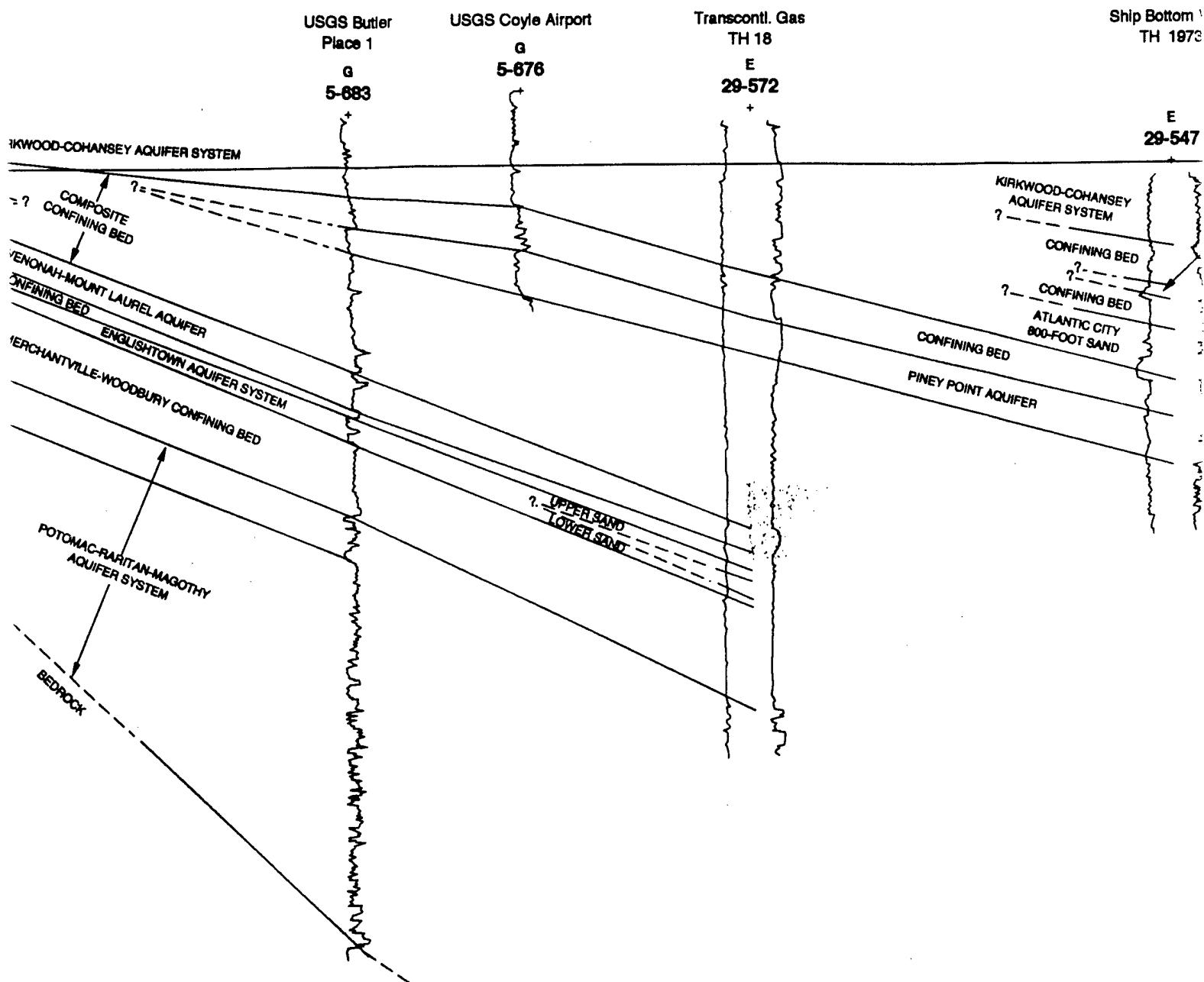


FIGURE 4
SITE GEOLOGIC MAP
TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

ABB Environmental Services, Inc.





URCE: ZAPECZA, 1984.

CROSS-SECTION O

FORT
AB

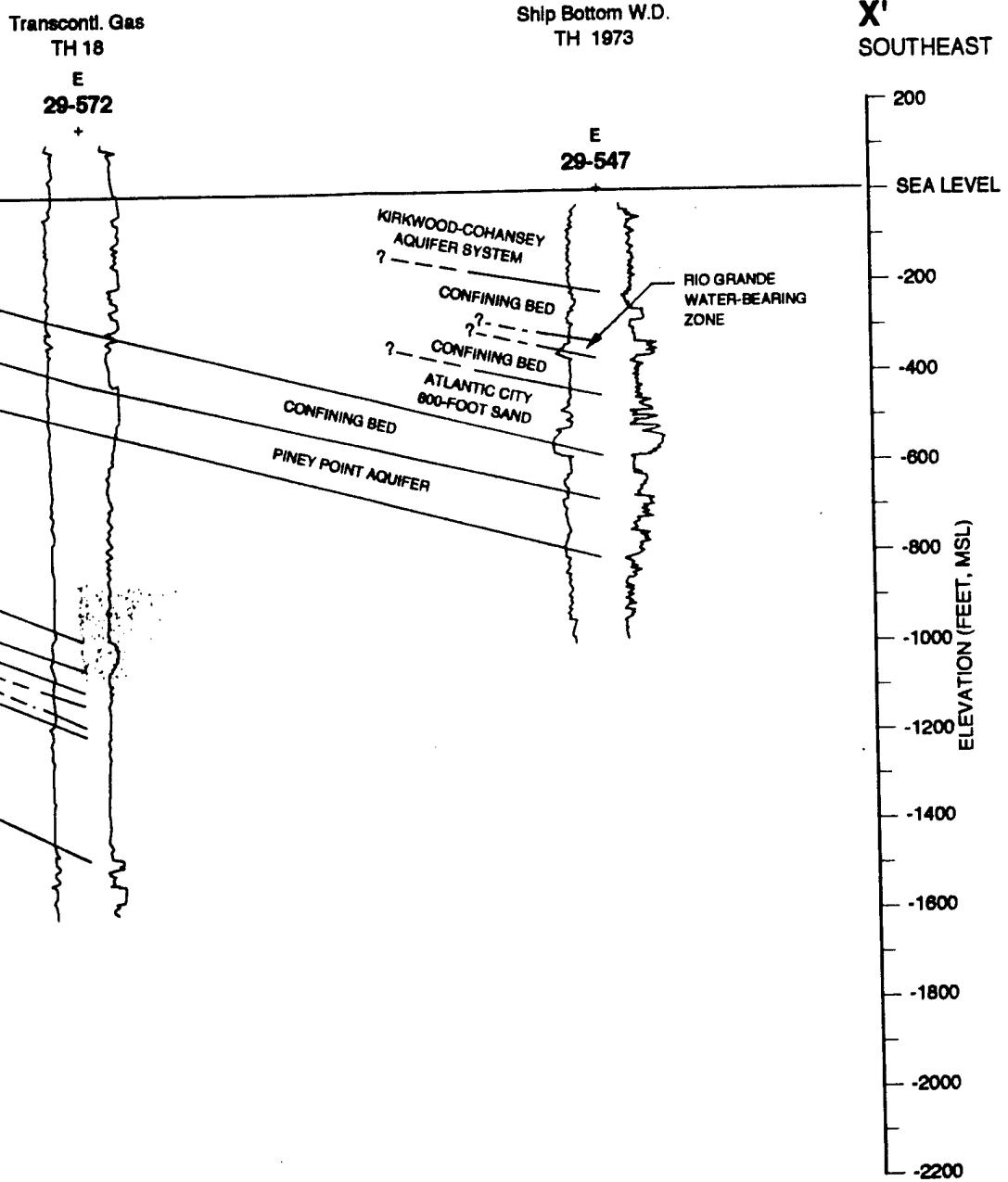
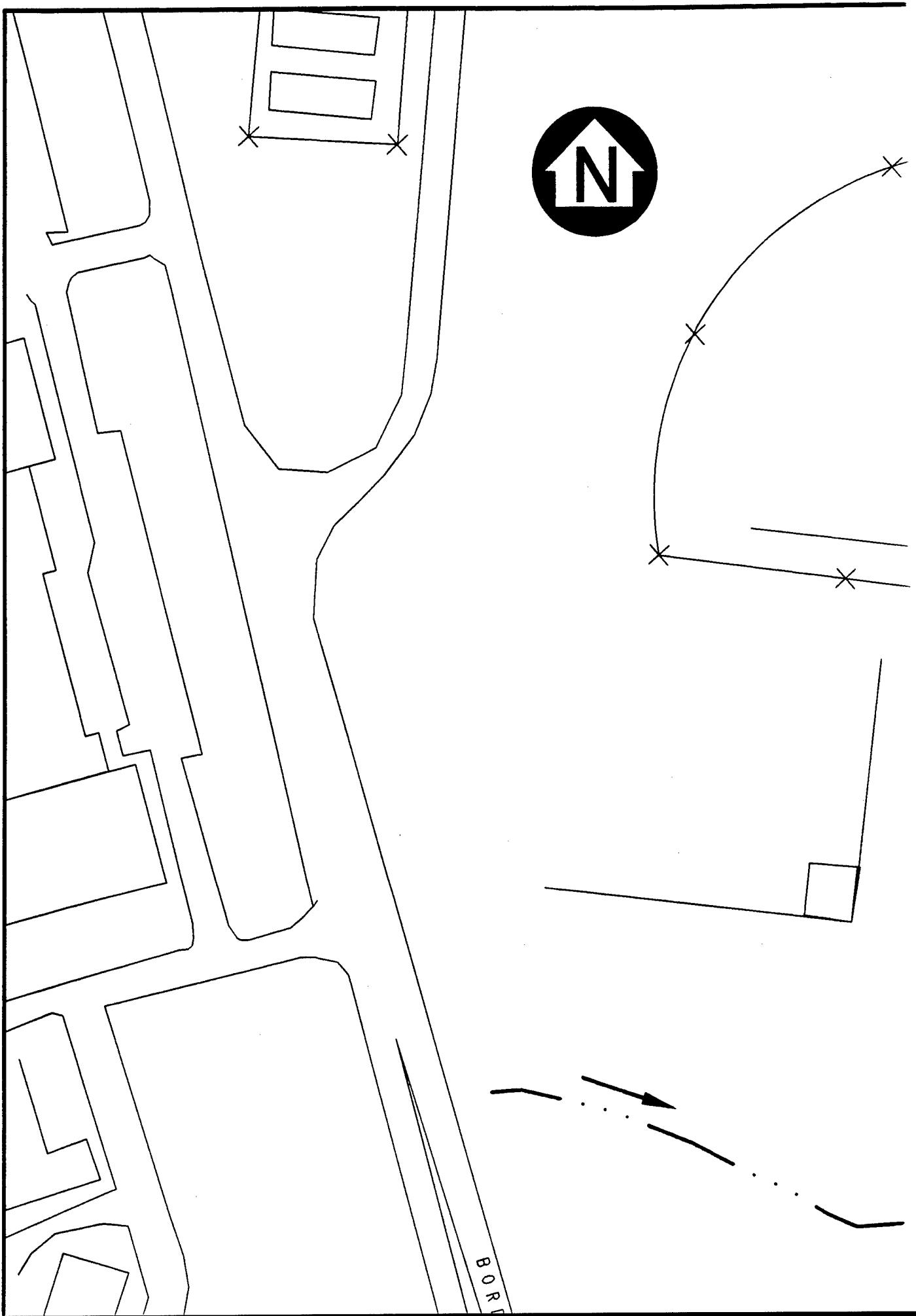


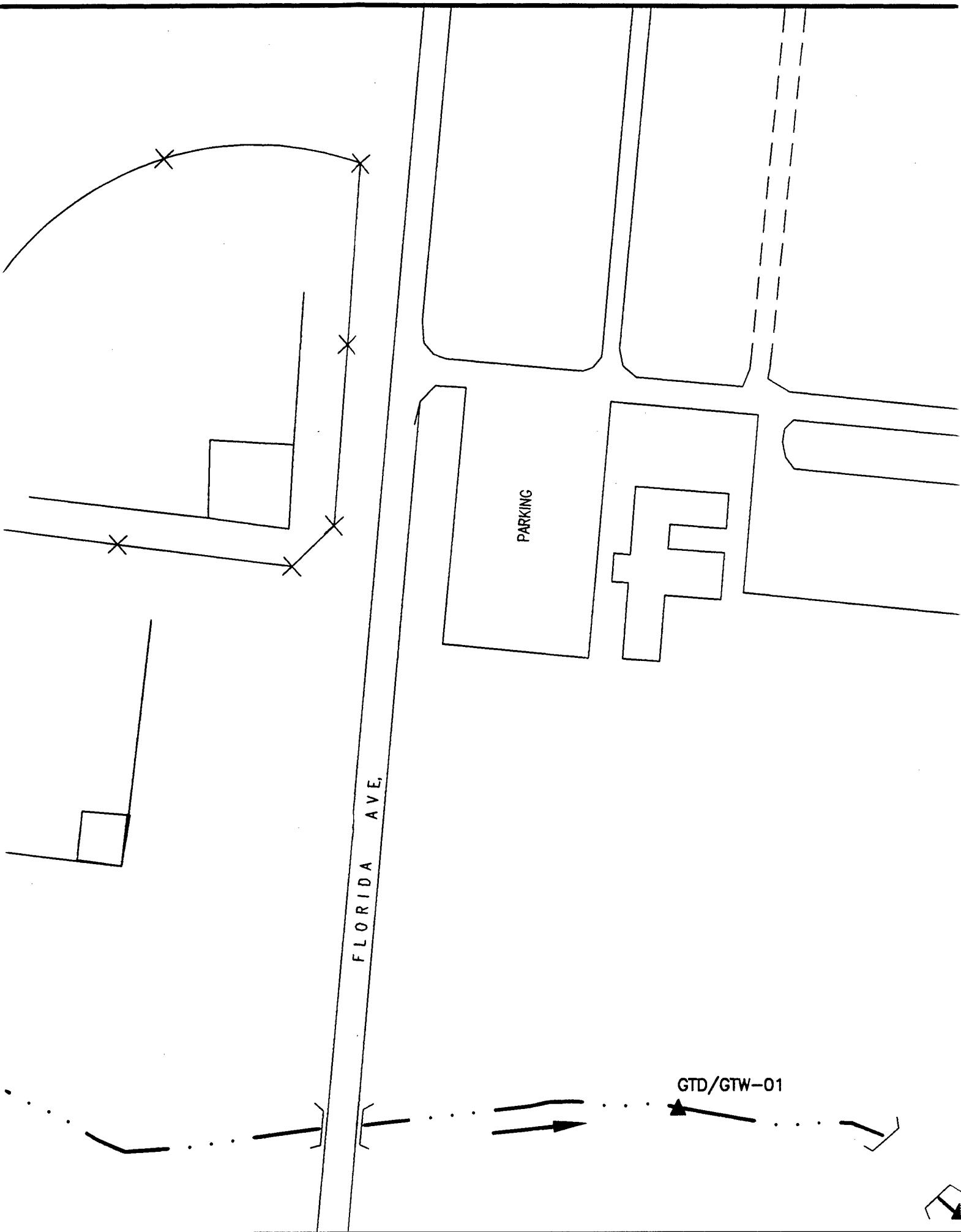
FIGURE 5
CROSS-SECTION OF REGIONAL GEOLOGY
TECHNICAL PLAN
FORT DIX RIVS FOR 13 SITES

ABB Environmental Services, Inc.

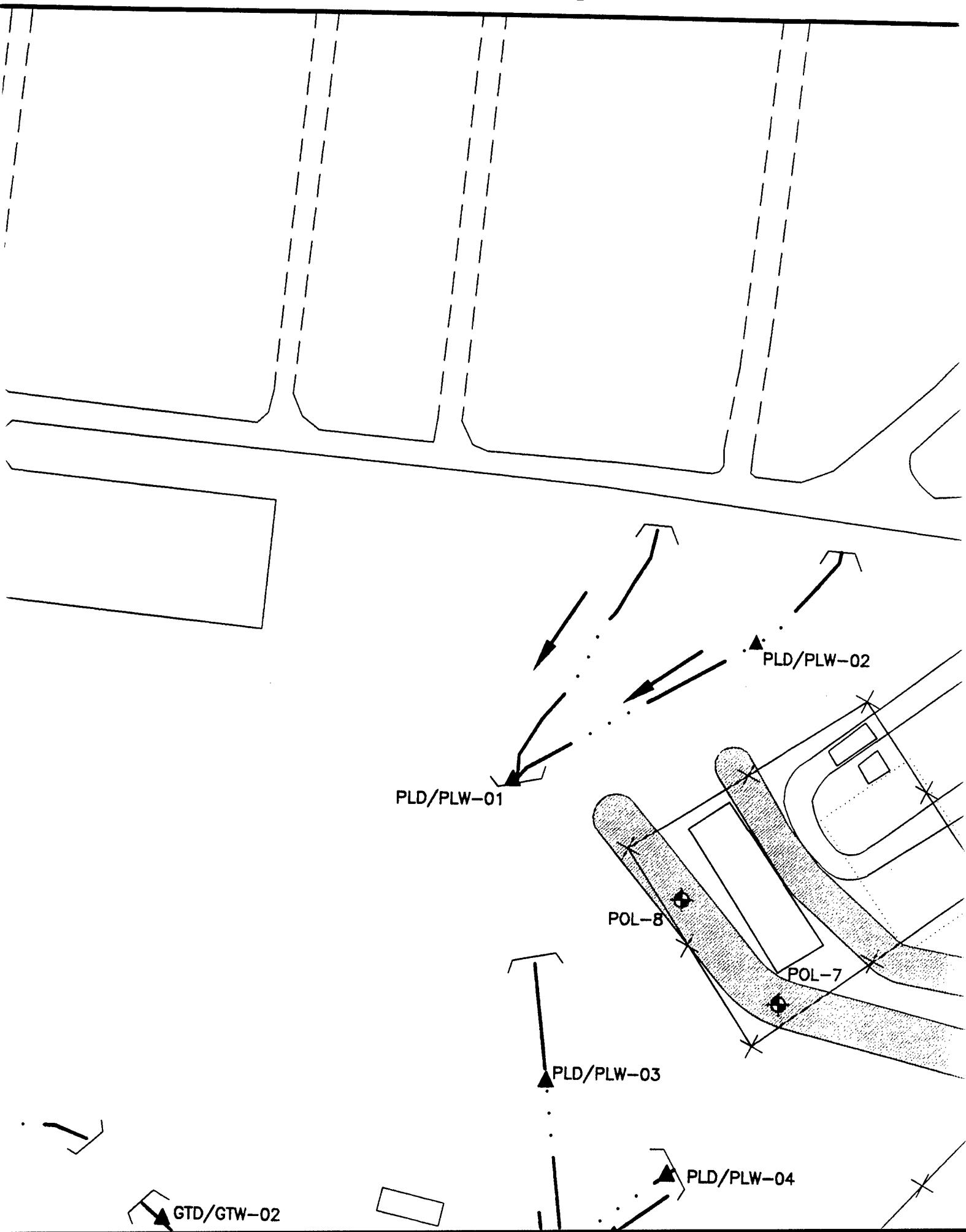
①



(2)

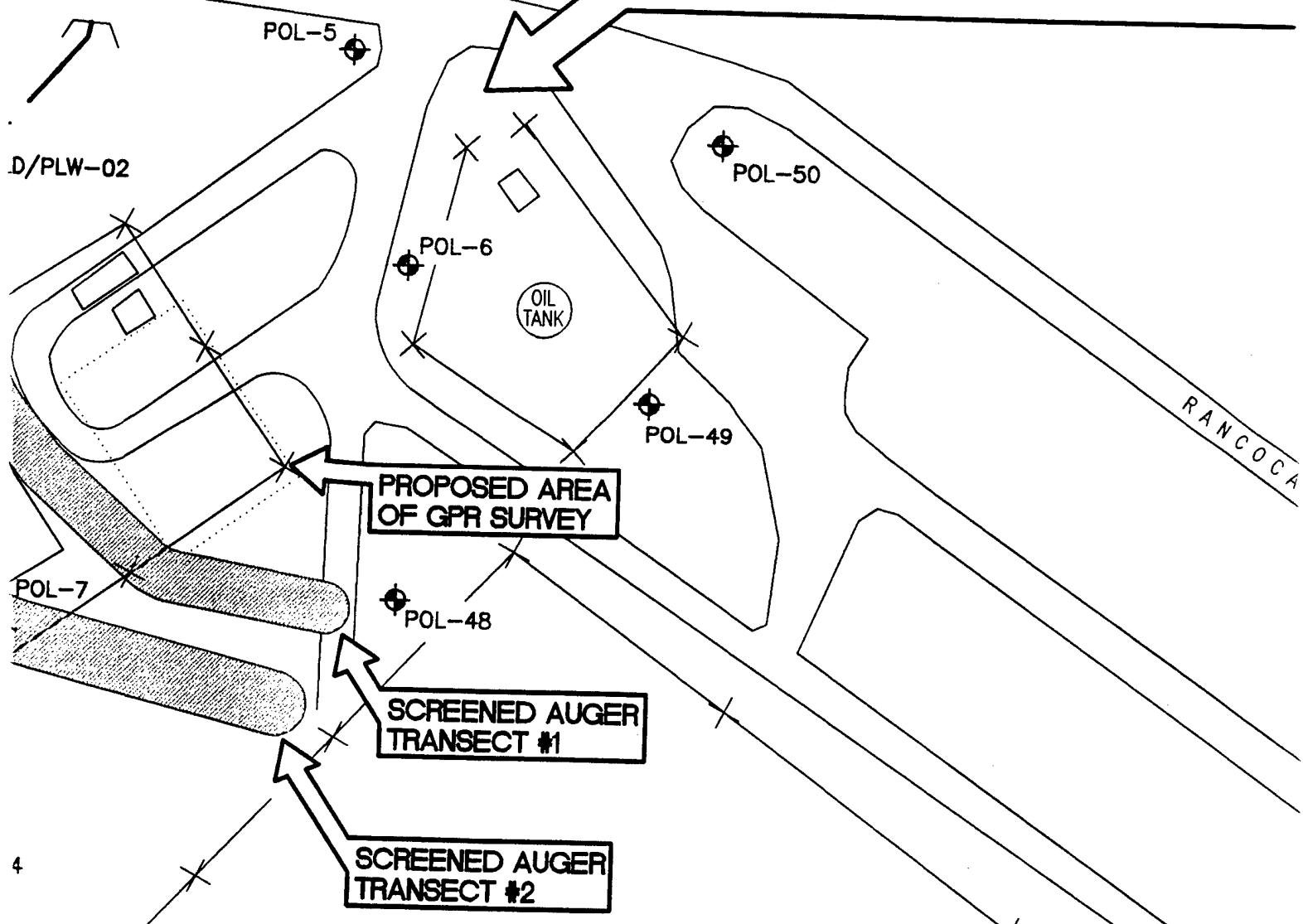


(3)

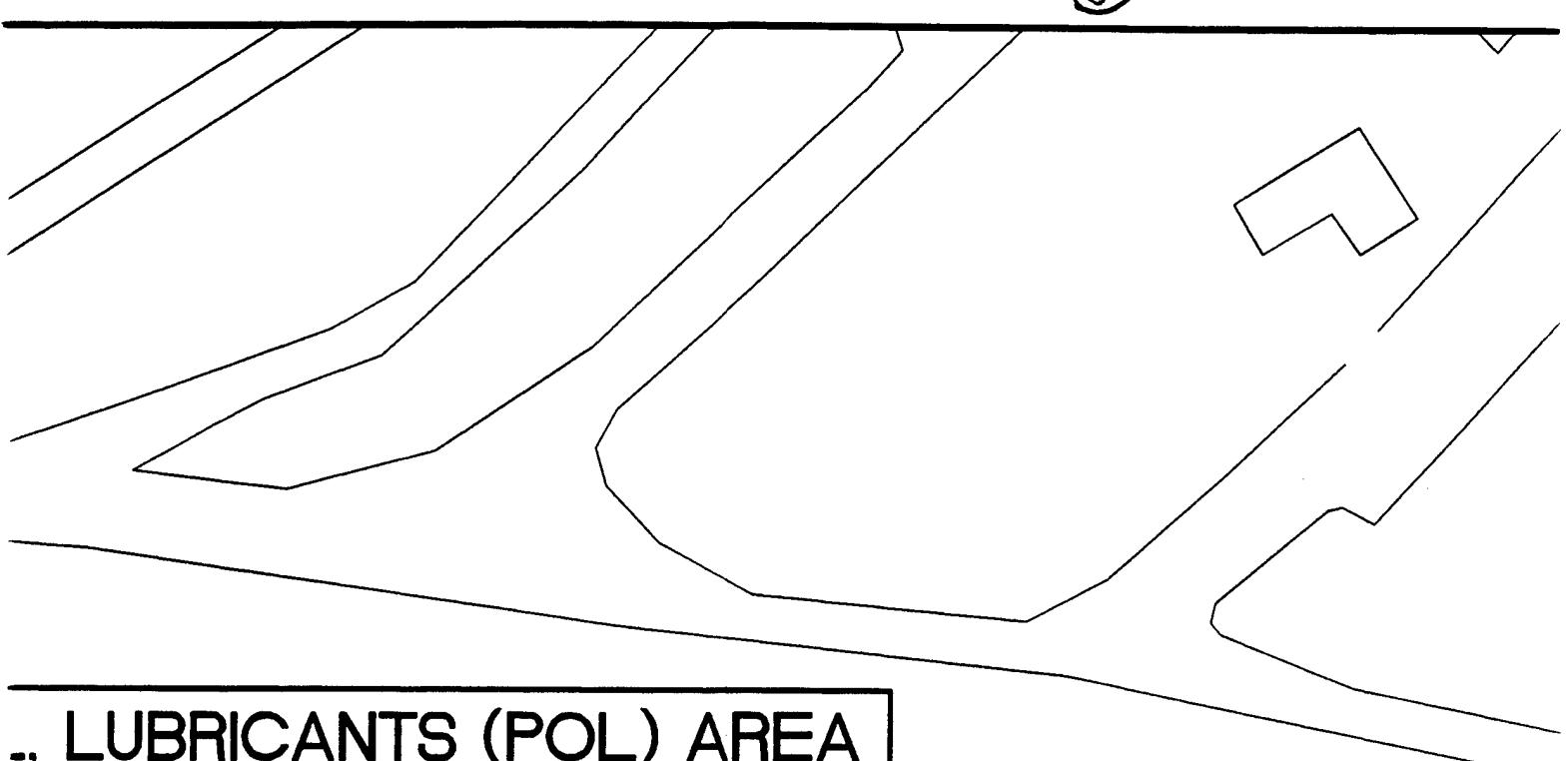


(4)

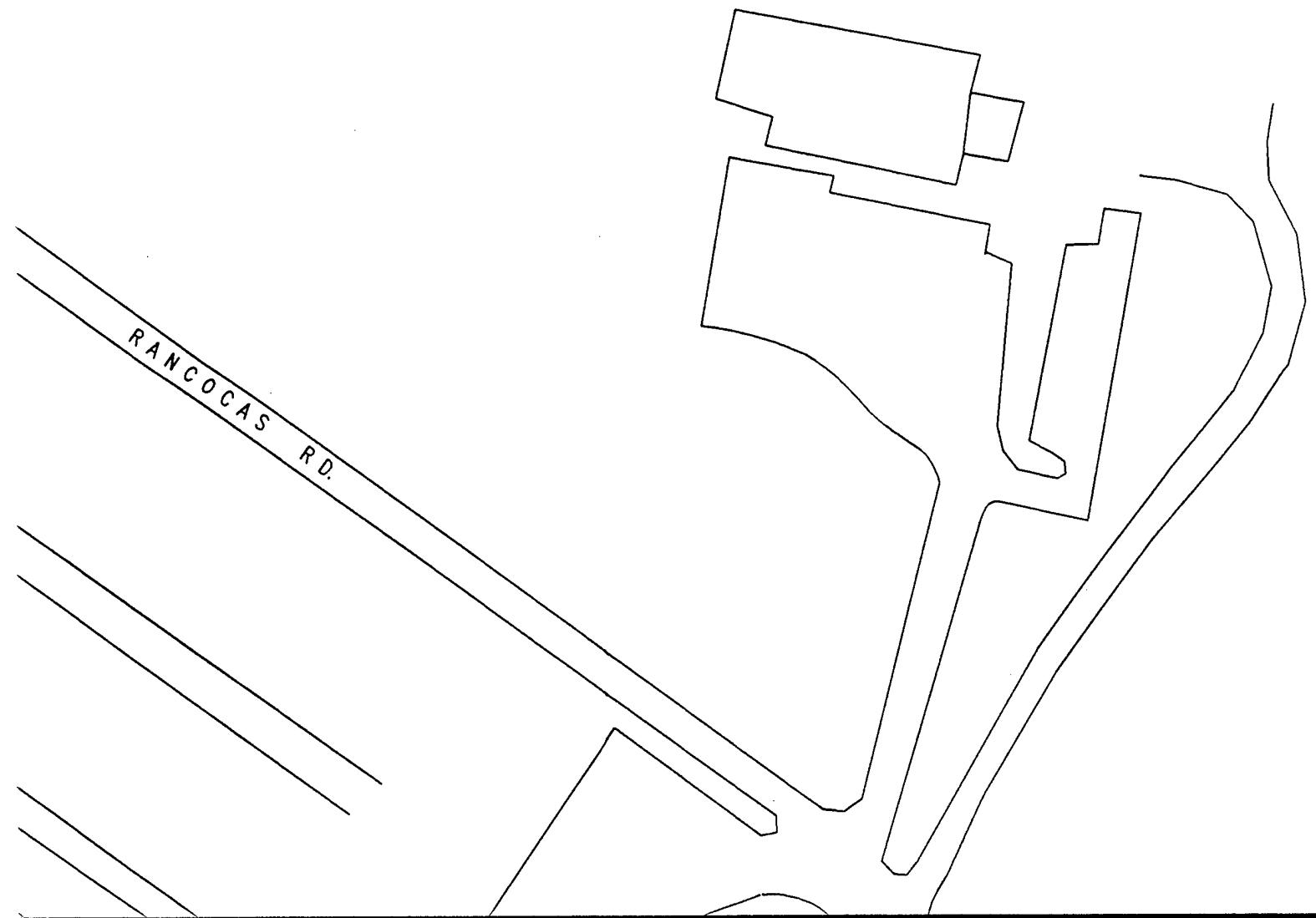
PETROLEUM, OIL, LUBRIC (SITE 2)



5

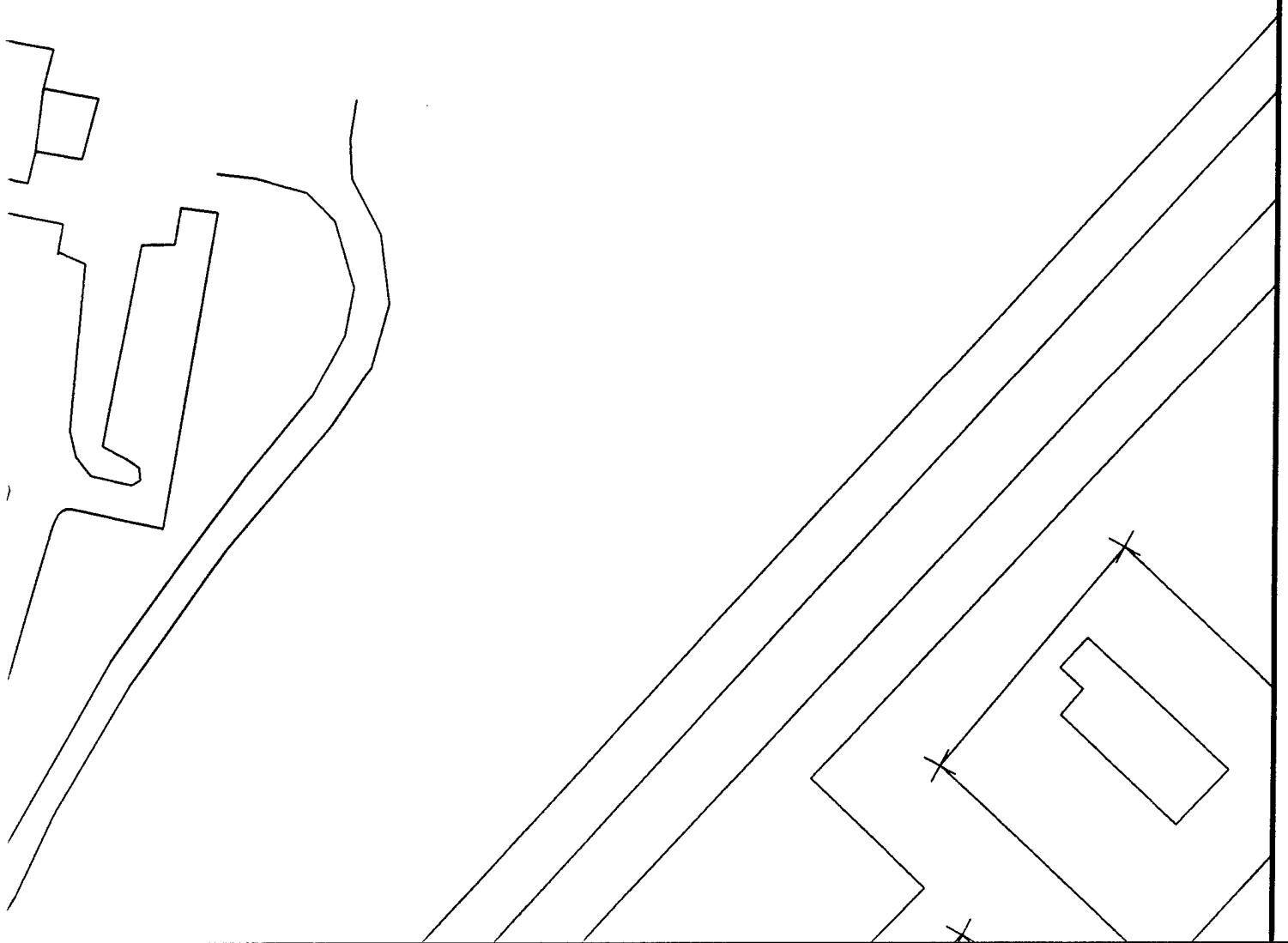
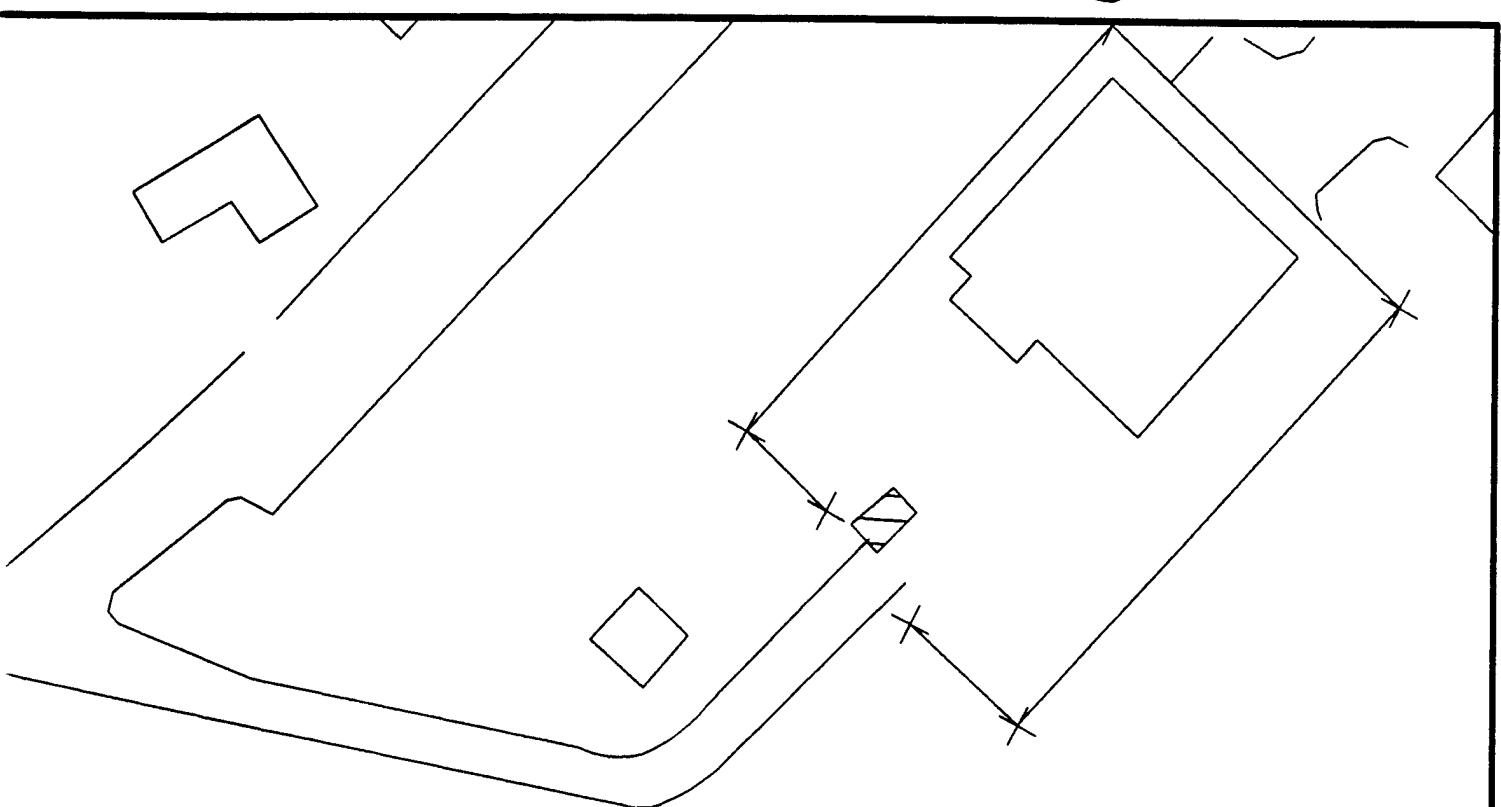


LUBRICANTS (POL) AREA



RANCOCAS RD.

(6)



(1)

BORDENTOWN

LEGEND

GTD/GTW-01 ▲

PROPOSED SURFACE WATER/SEDIMENT SAMPLE

GTCORE1 ■

PROPOSED SEDIMENT CORE LOCATION

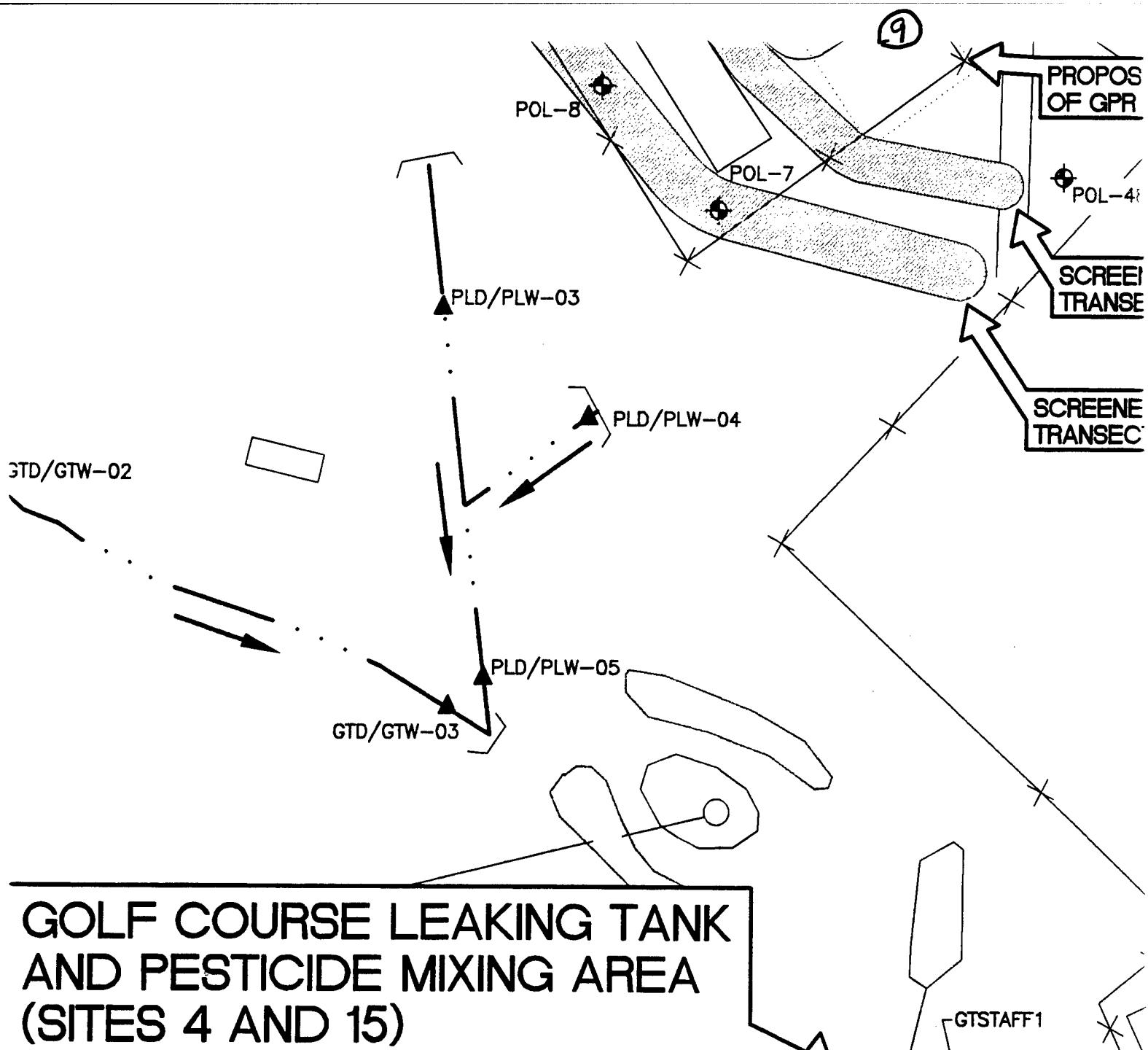
(8)

FLORIDA

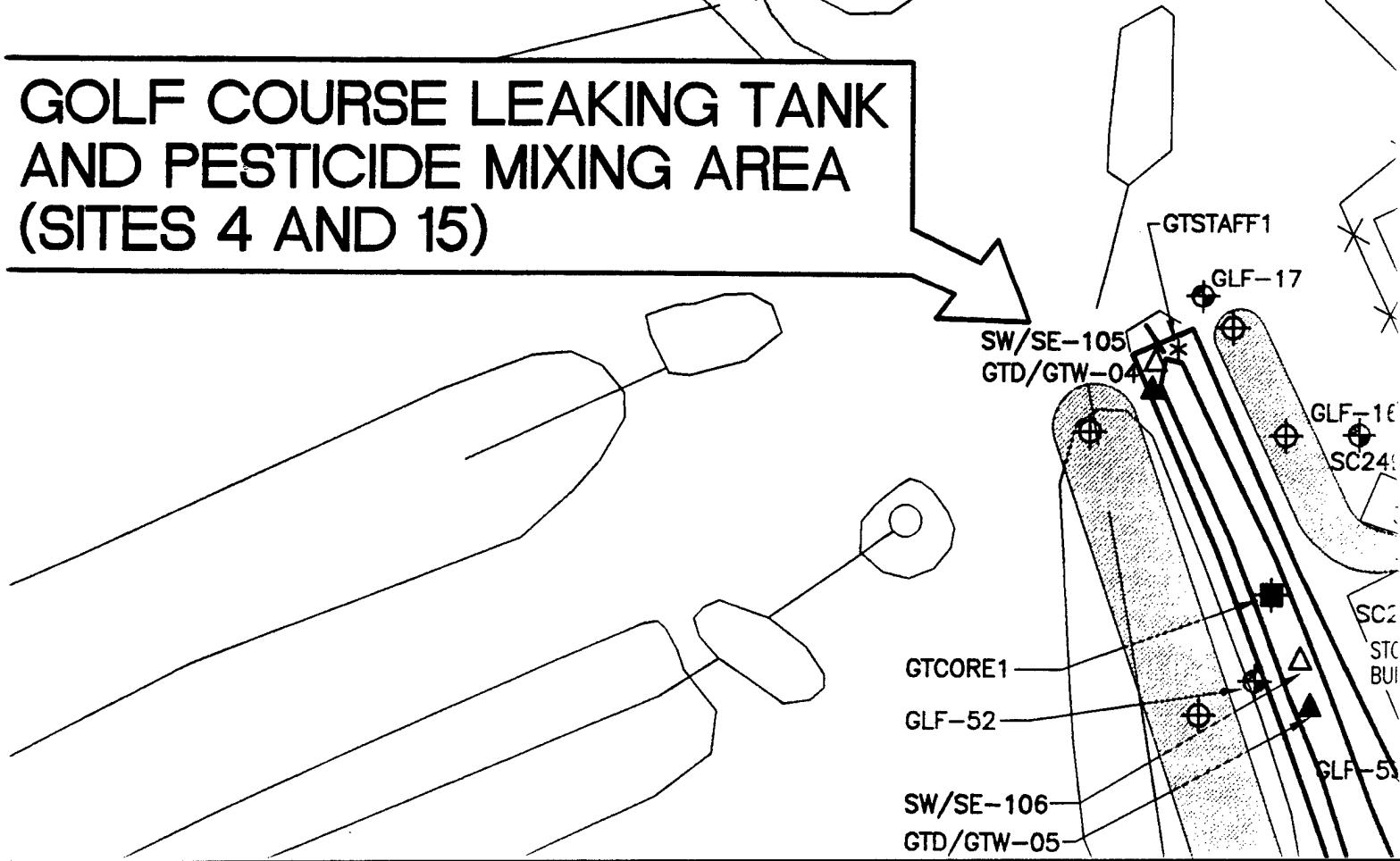
GTD/GTW-01

GTD/GTW-02

GOL
AND
(SITE)



GOLF COURSE LEAKING TANK AND PESTICIDE MIXING AREA (SITES 4 AND 15)



(10)

**PROPOSED AREA
OF GPR SURVEY**

POL-48

**SCREENED AUGER
TRANSECT #1**

**SCREENED AUGER
TRANSECT #2**

GOLF
DRIVING
RANGE

GLF-15

STORAGE
BUILDING

FORMER
LOCATION OF
LEAKING UST

17

SC-152

GPB-01

GPB-02

CONCRETE
PAD

FORMER PESTICIDE
MIXING AREA

SC-153

GLF-16

3151

SC243

SC-151

3150

SC-244

STORAGE
BUILDING

GLF-55

SC250

SC-151

SC251

SC245

SC246

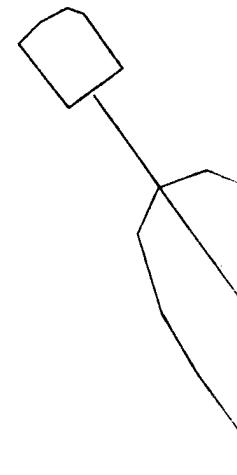
**GEOPROBE
TRANSECT #1**

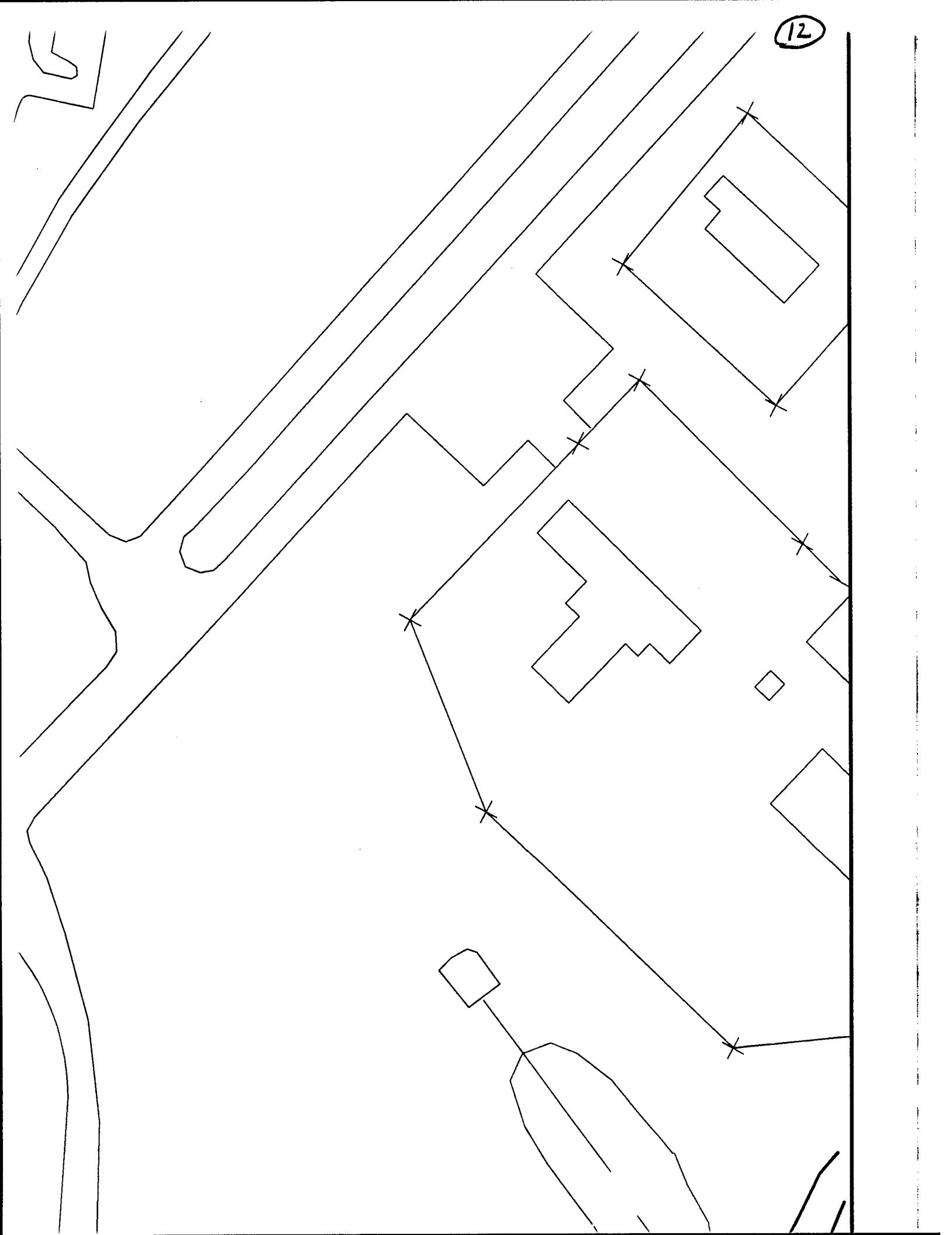
PARKING

CLUB
HOUSE

(11)

WAREHOUSE





LEGEND

GTD/GTW-01 ▲	PROPOSED SURFACE WATER/SEDIMENT SAMPLE
GTCORE1 ■	PROPOSED SEDIMENT CORE LOCATION
GPB-01 ●	PROPOSED SOIL BORING
⊕	PROPOSED GEOPROBE EXPLORATION LOCATION
GTSTAFF1 *	PROPOSED STAFF GAUGE
SW/SE-108 Δ	EXISTING SURFACE WATER/SEDIMENT SAMPLE
SC-151 ■	EXISTING SURFACE SOIL SAMPLE
SC248 ●	EXISTING BORING
GLF-74 ⊕	EXISTING MONITORING WELL
-----	CHAIN LINK FENCE
-----	DIRT ROADS
-----	PAVED ROADS
— · —	STREAM AND FLOW DIRECTION
.....	GEOPHYSICAL SURVEY BOUNDARY

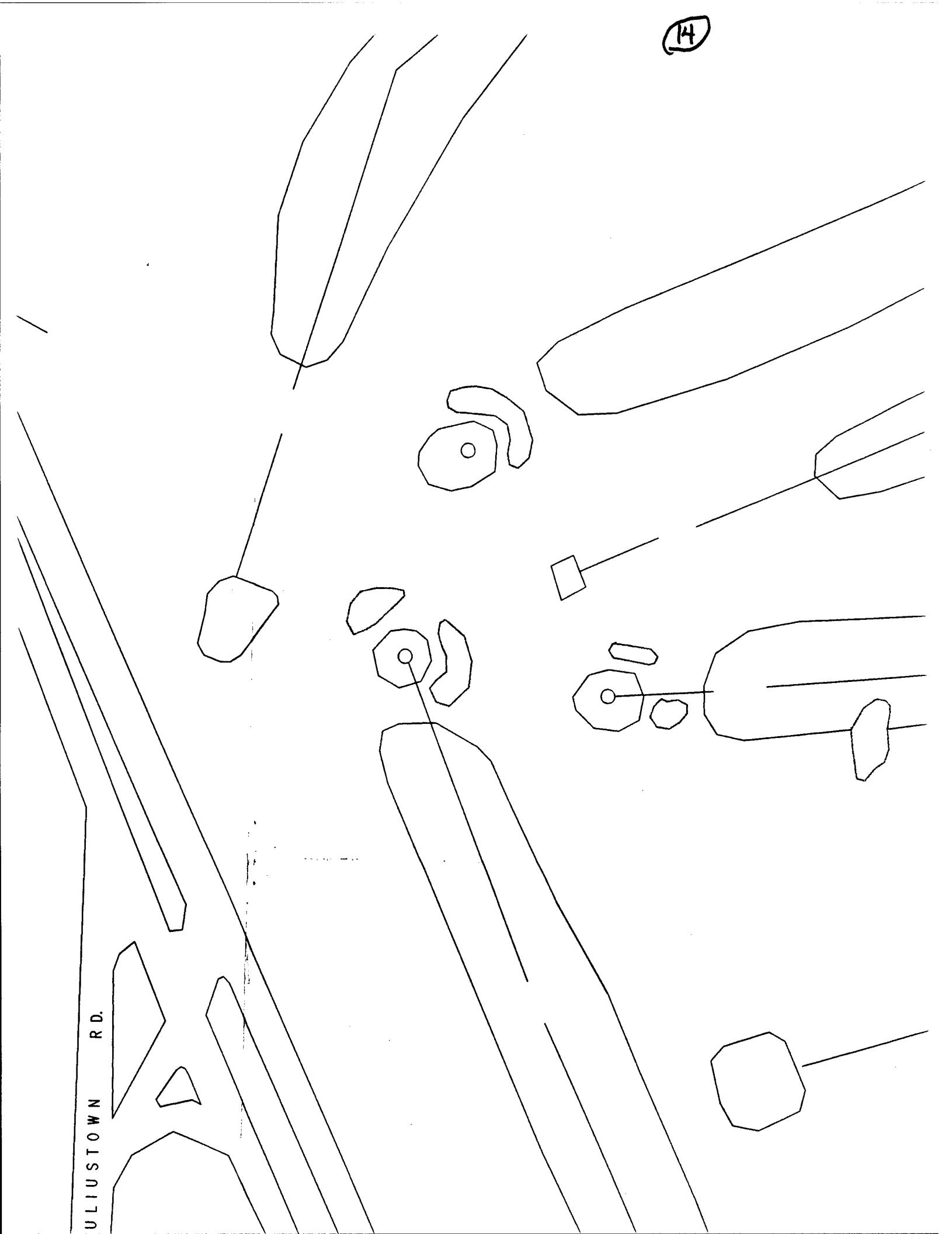
SITE 2 NOTES:

1. THIS FIGURE SHOWS THE LOCATION OF TWO GEOPROBE/SCREENED AUGER TRANSECTS FOR GROUNDWATER FIELD SCREENING. UP TO 5 TOTAL GEOPROBE/SCREENED AUGER BORINGS WILL BE DRILLED IN THESE AREAS. FINAL LOCATIONS AND NUMBERS OF BORINGS WILL BE DETERMINED DURING THE FIELD PROGRAM BASED ON FIELD SCREENING ANALYTICAL RESULTS.
2. UP TO 5 FIELD SCREENING BORINGS FOR SOIL SAMPLES WILL BE INSTALLED IN THE PROPOSED AREA OF GPR SURVEY, BASED ON GPR SURVEY RESULTS.
3. LOCATIONS AND NUMBERS OF PROPOSED MONITORING WELLS (NOT SHOWN) WILL BE DETERMINED BASED ON ANALYTICAL RESULTS FROM THE SCREENED AUGER BORINGS. UP TO 5 ADDITIONAL MONITORING WELLS WILL BE INSTALLED.

SITES 4 AND 15 NOTES:

1. THIS FIGURE SHOWS APPROXIMATE LOCATIONS OF 14 OF THE PROPOSED 21 GEOPROBE/SCREENED AUGER EXPLORATION LOCATIONS. FINAL LOCATIONS AND NUMBERS OF EXPLORATIONS WILL BE DETERMINED DURING THE FIELD PROGRAM BASED ON FIELD SCREENING ANALYTICAL RESULTS.

(14)



(15)

SW/SE-105
GTD/GTW-04

G

GTCORE1

GLF-52

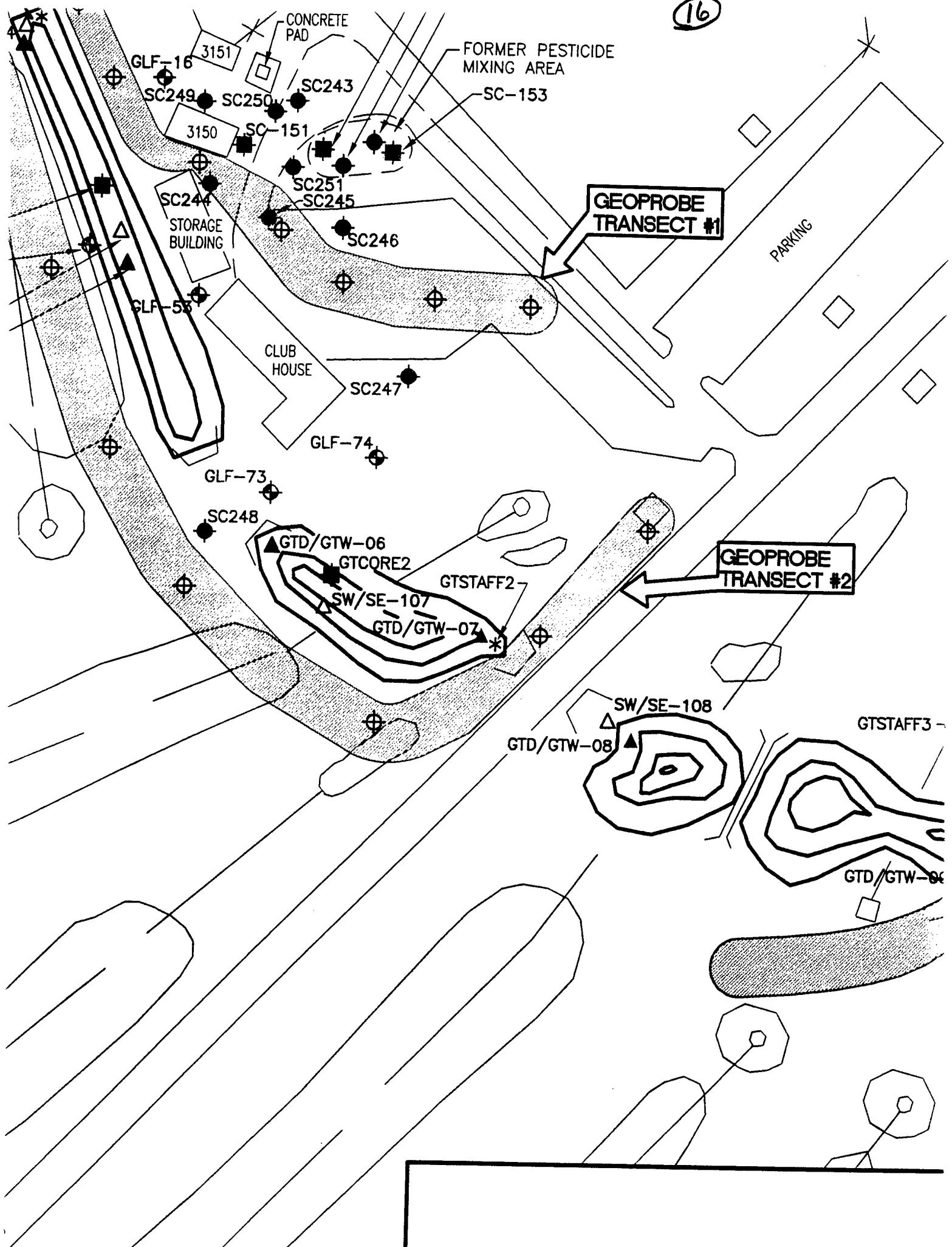
SW/SE-106

GTD/GTW-05

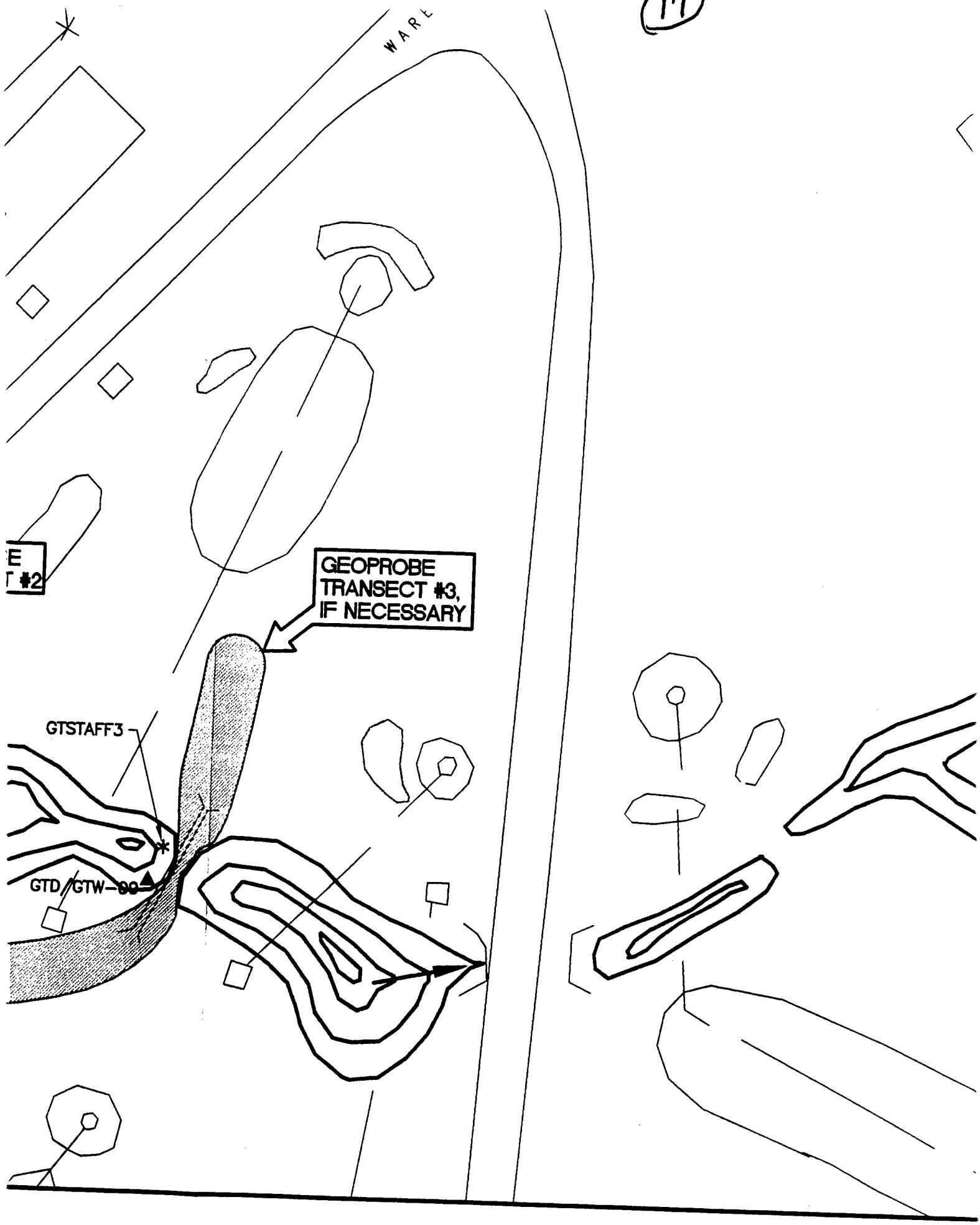
GOLF COURSE

A.D.

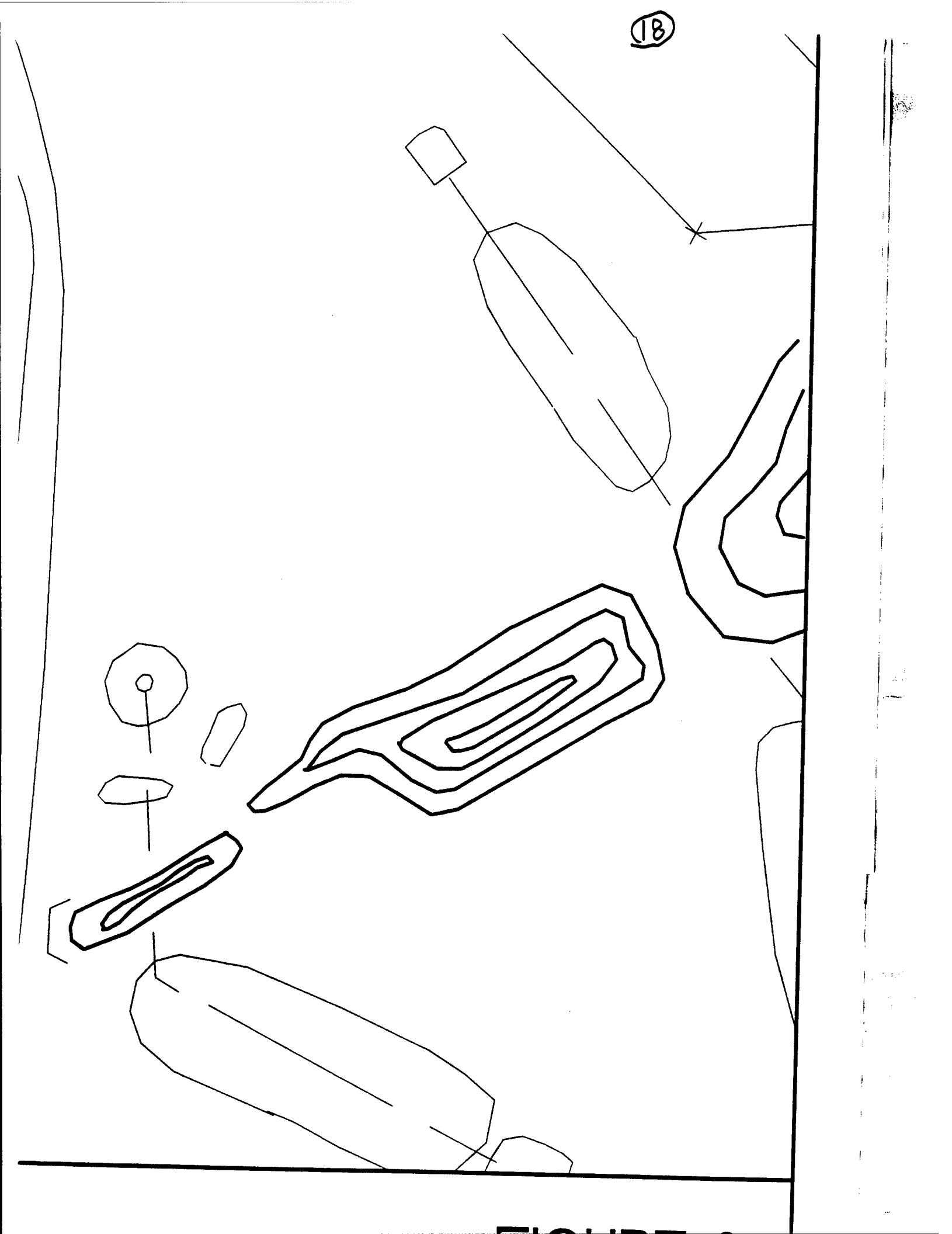
16



17



(1B)



GEOPROBE/SCREENED AUGER BORINGS WILL BE DRILLED IN THESE AREAS. FINAL LOCATIONS AND NUMBERS OF BORINGS WILL BE DETERMINED DURING THE FIELD PROGRAM BASED ON FIELD SCREENING ANALYTICAL RESULTS.

(19)

2. UP TO 5 FIELD SCREENING BORINGS FOR SOIL SAMPLES WILL BE INSTALLED IN THE PROPOSED AREA OF GPR SURVEY, BASED ON GPR SURVEY RESULTS.
3. LOCATIONS AND NUMBERS OF PROPOSED MONITORING WELLS (NOT SHOWN) WILL BE DETERMINED BASED ON ANALYTICAL RESULTS FROM THE SCREENED AUGER BORINGS. UP TO 5 ADDITIONAL MONITORING WELLS WILL BE INSTALLED.

JULIUSTOWN R.D.

SITES 4 AND 15 NOTES:

1. THIS FIGURE SHOWS APPROXIMATE LOCATIONS OF 14 OF THE PROPOSED 21 GEOPROBE/SCREENED AUGER EXPLORATION LOCATIONS. FINAL LOCATIONS AND NUMBERS OF EXPLORATIONS WILL BE DETERMINED DURING THE FIELD PROGRAM BASED ON FIELD SCREENING ANALYTICAL RESULTS.
2. LOCATIONS OF PROPOSED MONITORING WELLS (NOT SHOWN) WILL BE DETERMINED BASED ON FIELD SCREENING ANALYTICAL RESULTS FROM GEOPROBE EXPLORATIONS. 4 MONITORING WELL PAIRS (8 WELLS) AND UP TO 4 ADDITIONAL MONITORING WELLS ARE PROPOSED.

GENERAL NOTES:

1. LOCATIONS OF ALL PREVIOUS INVESTIGATIOINS ARE APPROXIMATE.
2. CAD BASE MAP SOURCE: FORT DIX

0 50 100 200 FEET

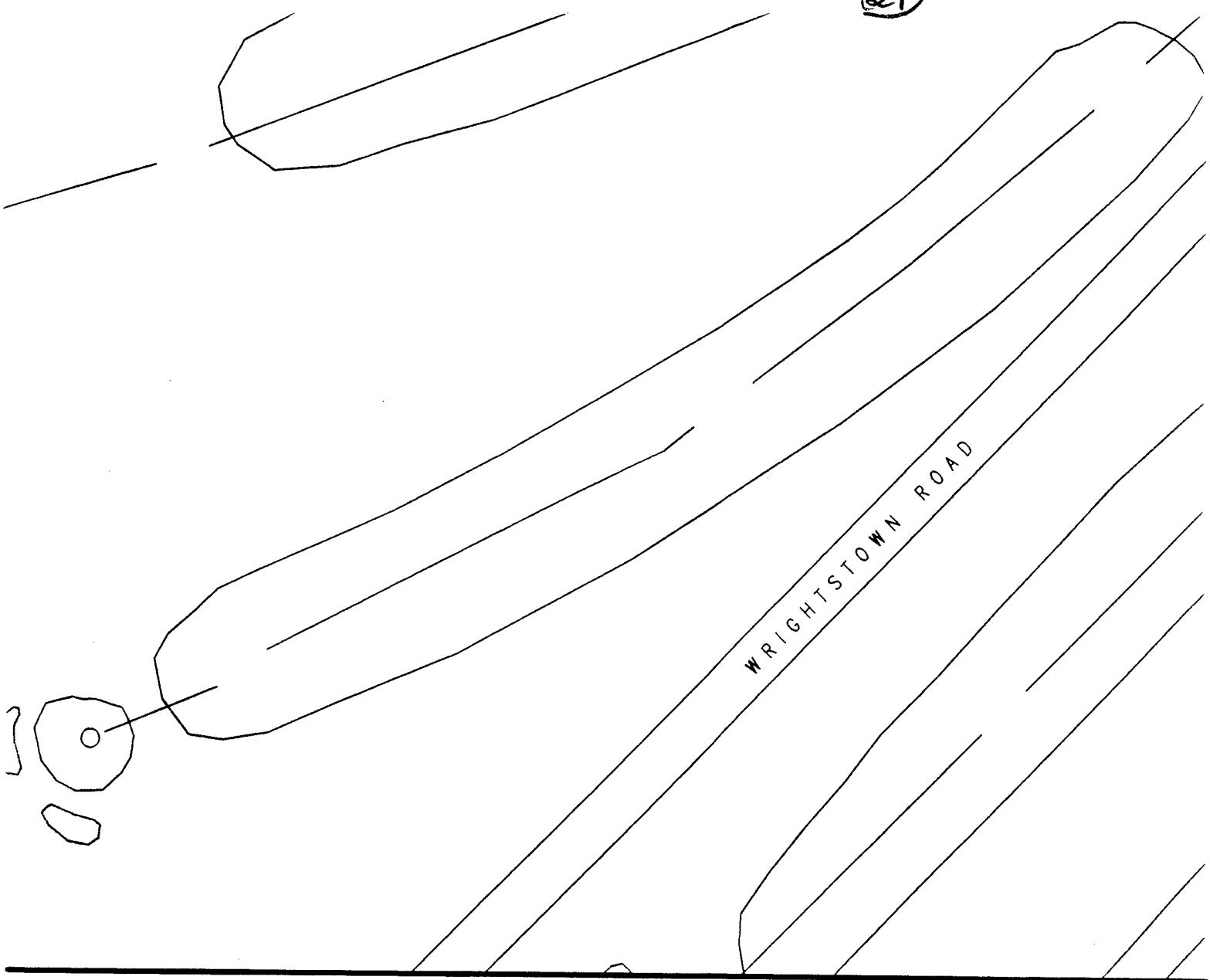
SCALE: 1"=100'

(20)

JULIUSTOWN R.D.

ACCESS HIGHWAY

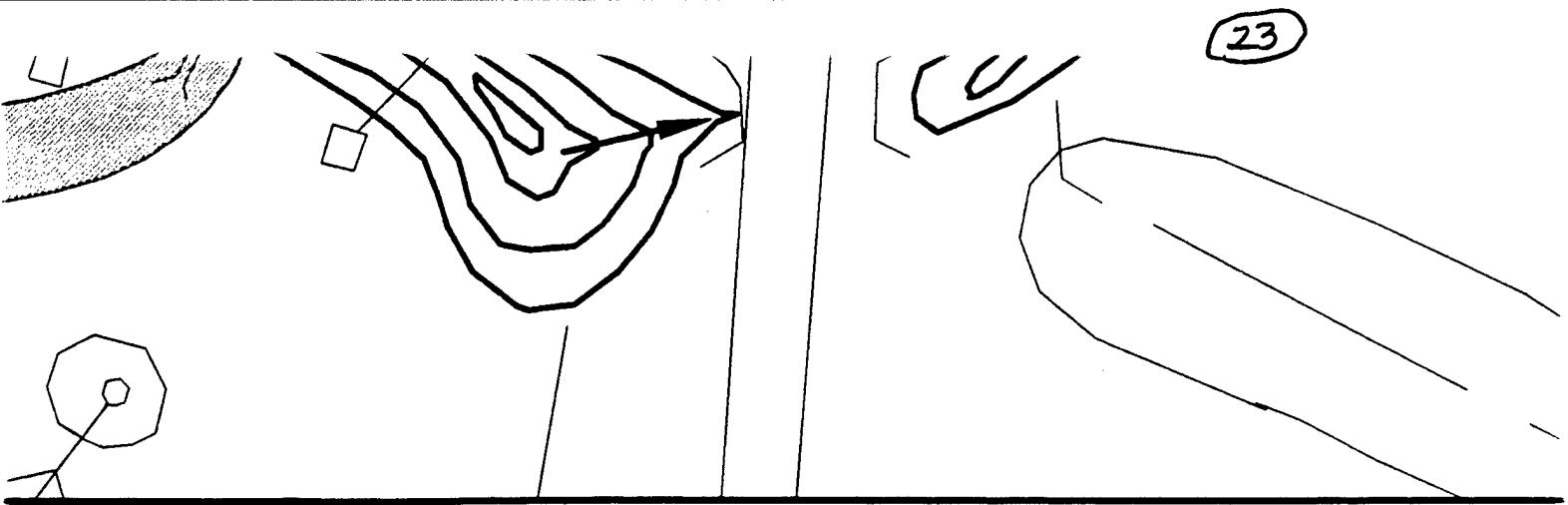
(21)



22

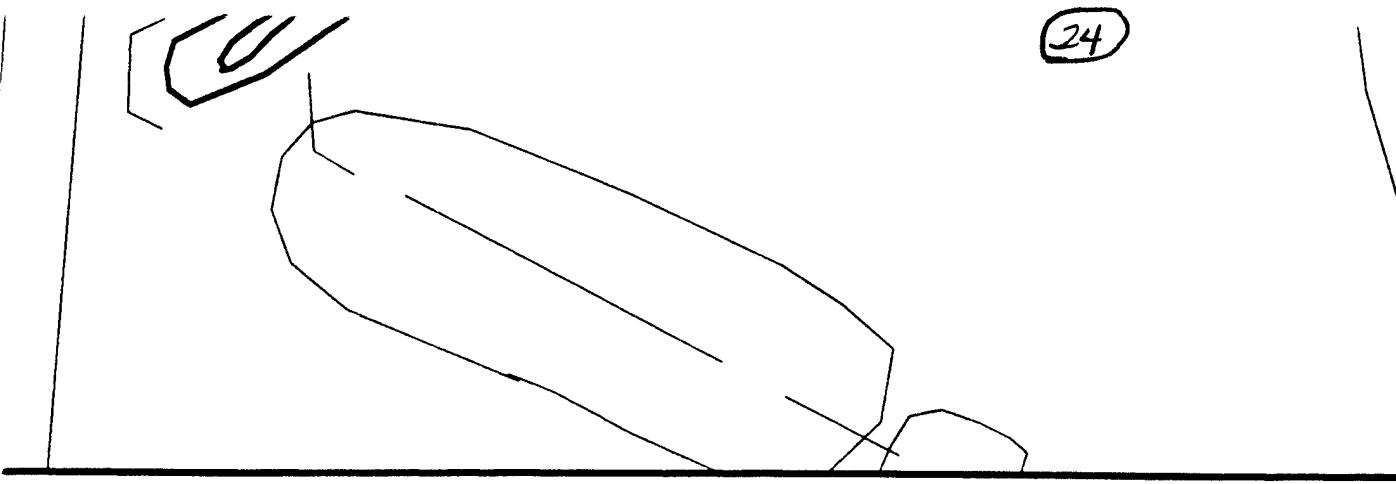


LOCATIONS OF EXIS

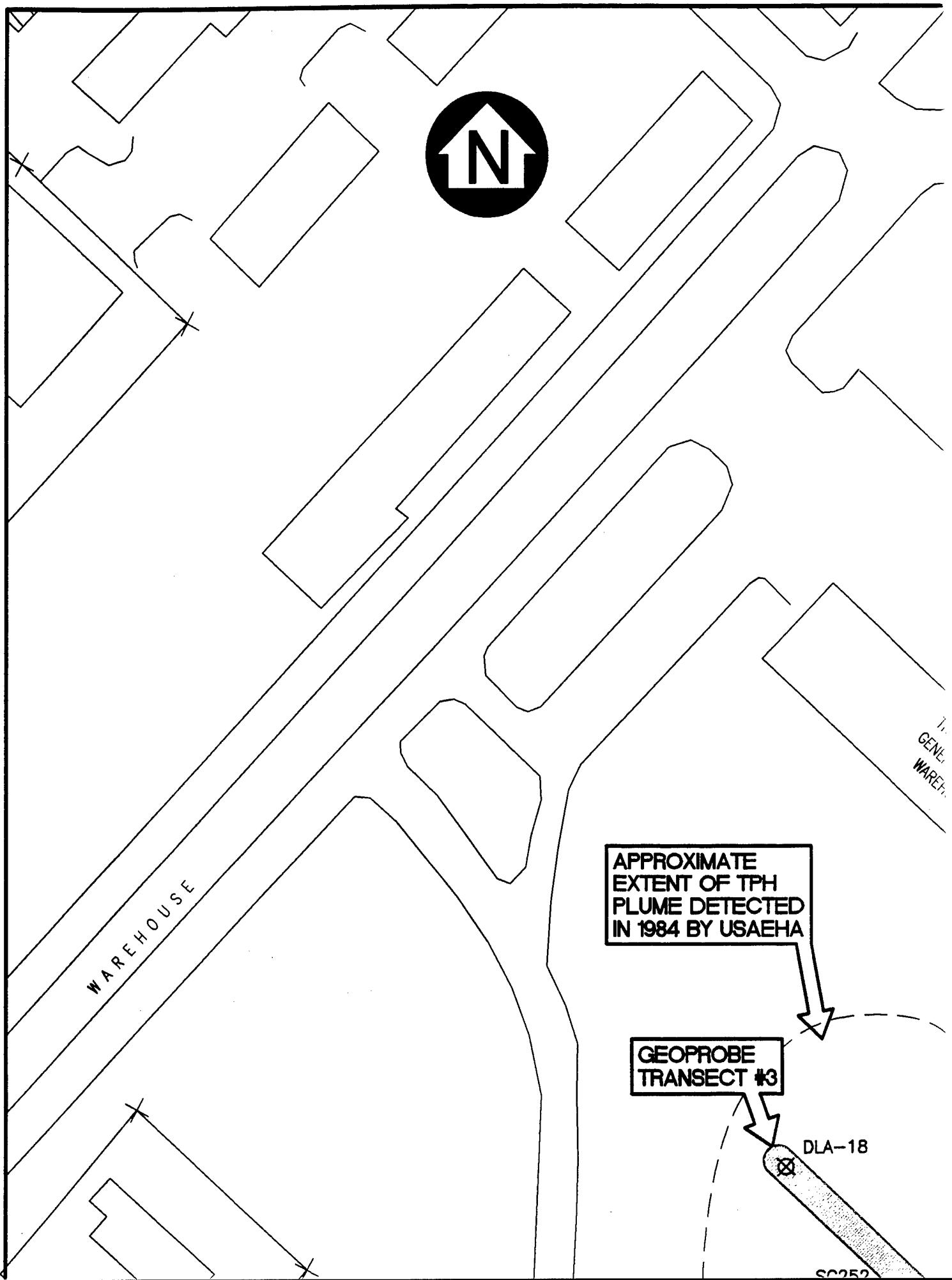


**GOLF COURSE LEA
PESTICIDE M
PETROLEUM, OIL, LUBRICANT
F EXISTING AND PROPOSED INVE
FORT DIX RI/FS FC**

ABB Environmental



**FIGURE 6
OLF COURSE LEAKING TANK,
PESTICIDE MIXING AND
UM, OIL, LUBRICANTS AREAS
PROPOSED INVESTIGATIONS
FORT DIX RI/FS FOR 13 SITES
— ABB Environmental Services, Inc.**



APPROXIMATE
EXTENT OF TPH
PLUME DETECTED
IN 1984 BY USAEHA

GEOPROBE
TRANSECT #3

DLA-18

SC252

(2)

TRANSPORTATION
GENERAL PURPOSE
WAREHOUSE

NDL-60

NDL-61

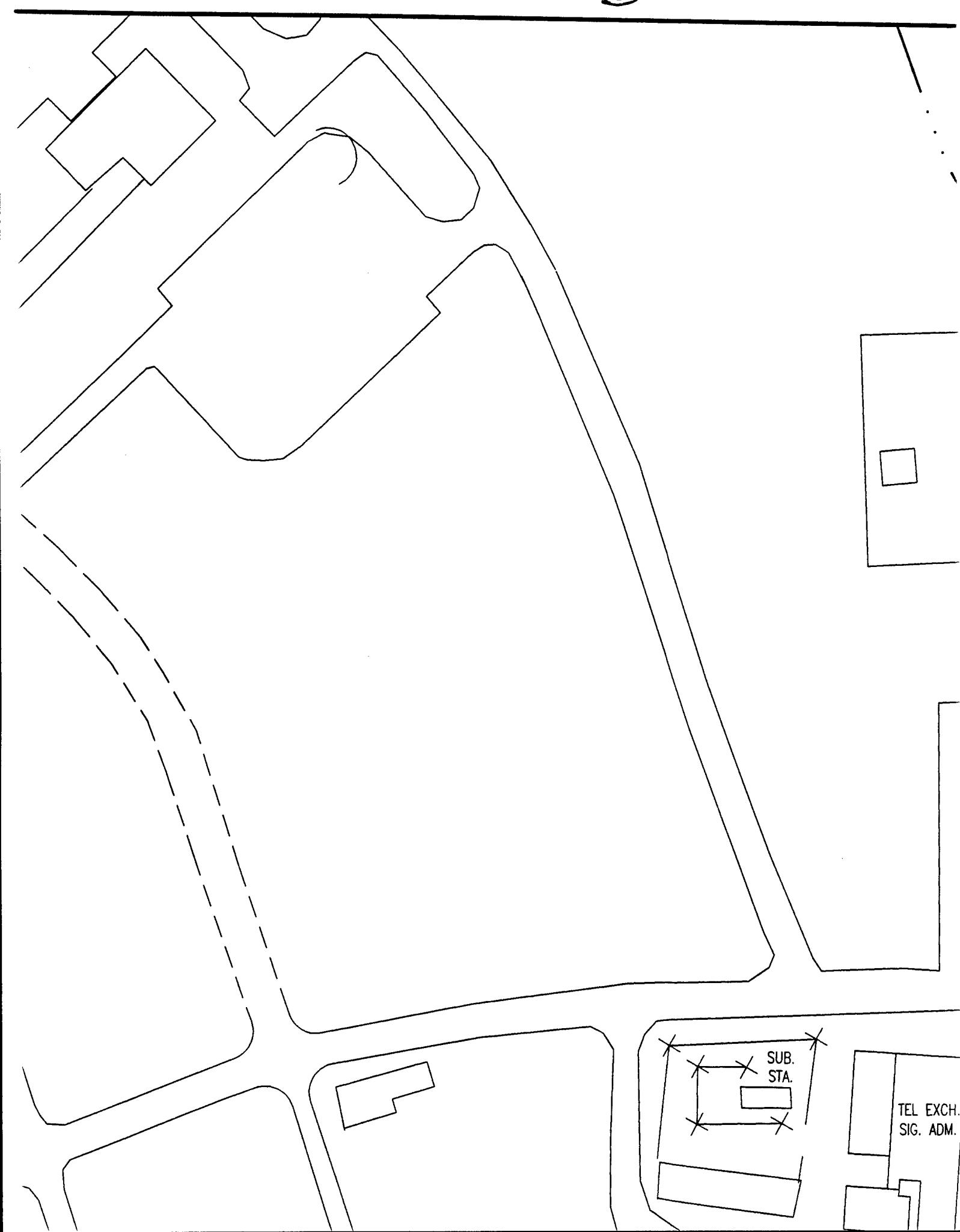
AIRFIELD ROAD

LA-18

SC252

AREA NORTH

(3)



(4)

PCD/PCW-01

PCD/PCW-C

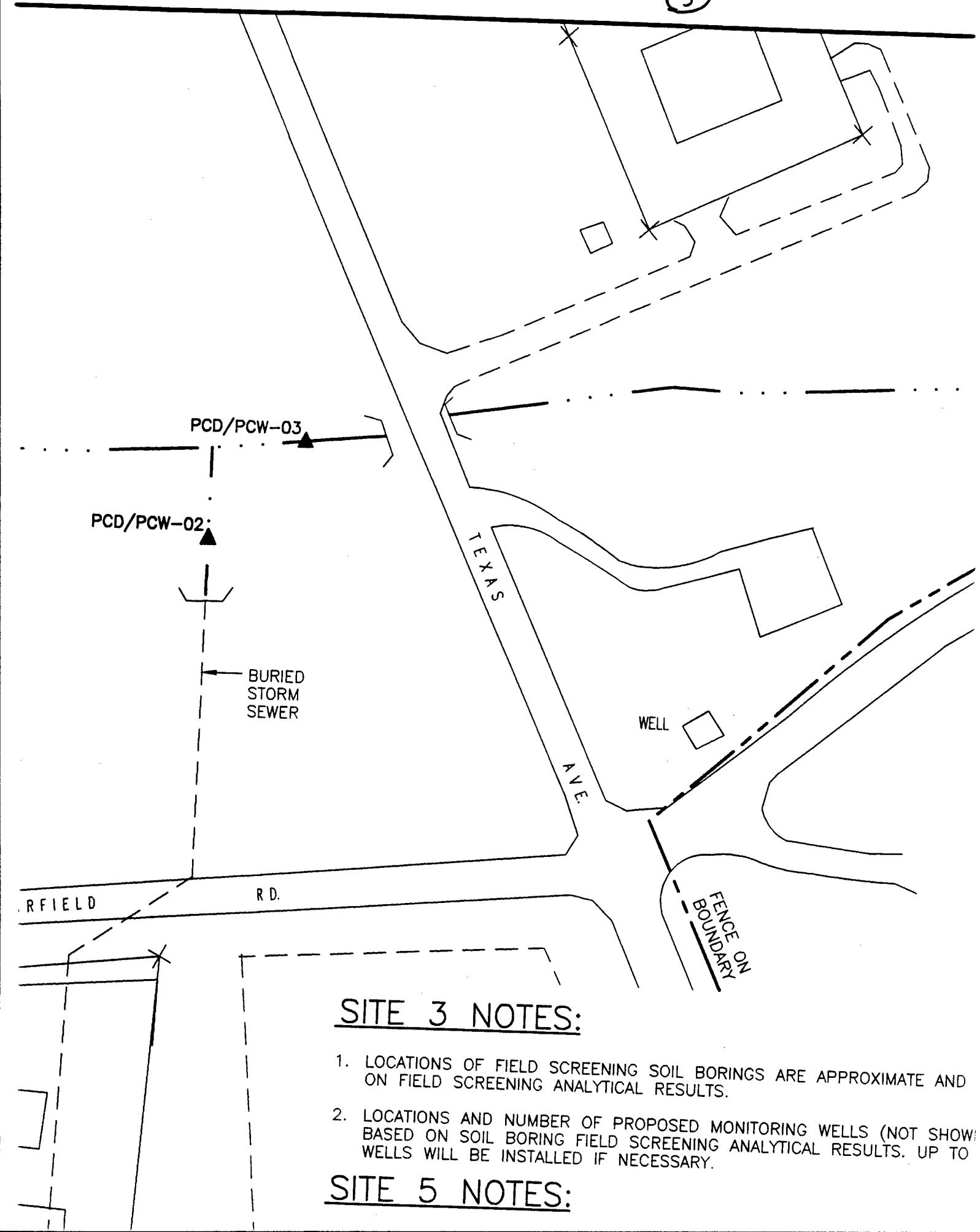
PX
ADMIN

AIRFIELD

TEL EXCH.
SIG. ADM.

SHOP

(5)

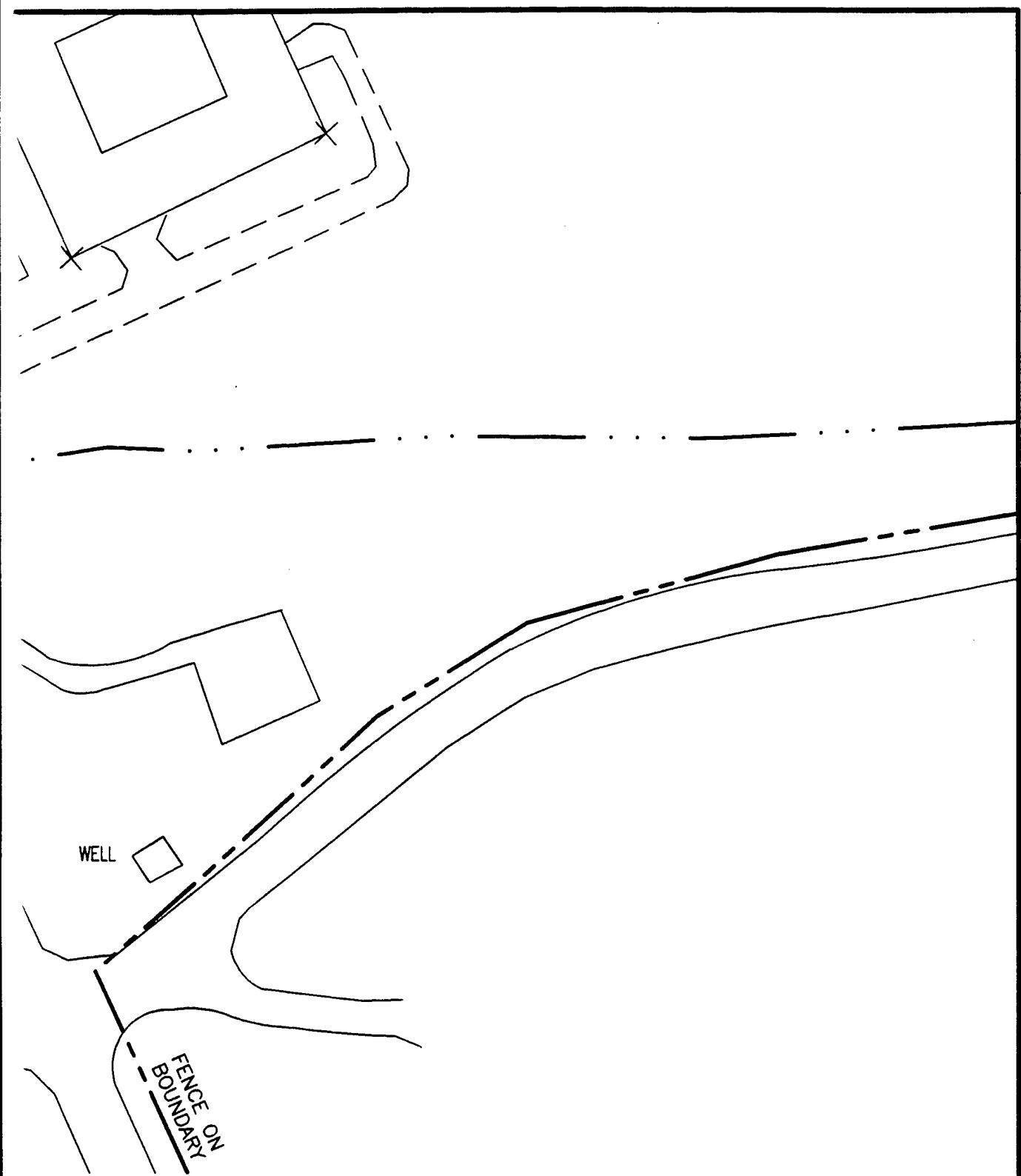


SITE 3 NOTES:

1. LOCATIONS OF FIELD SCREENING SOIL BORINGS ARE APPROXIMATE AND ON FIELD SCREENING ANALYTICAL RESULTS.
2. LOCATIONS AND NUMBER OF PROPOSED MONITORING WELLS (NOT SHOWN) BASED ON SOIL BORING FIELD SCREENING ANALYTICAL RESULTS. UP TO WELLS WILL BE INSTALLED IF NECESSARY.

SITE 5 NOTES:

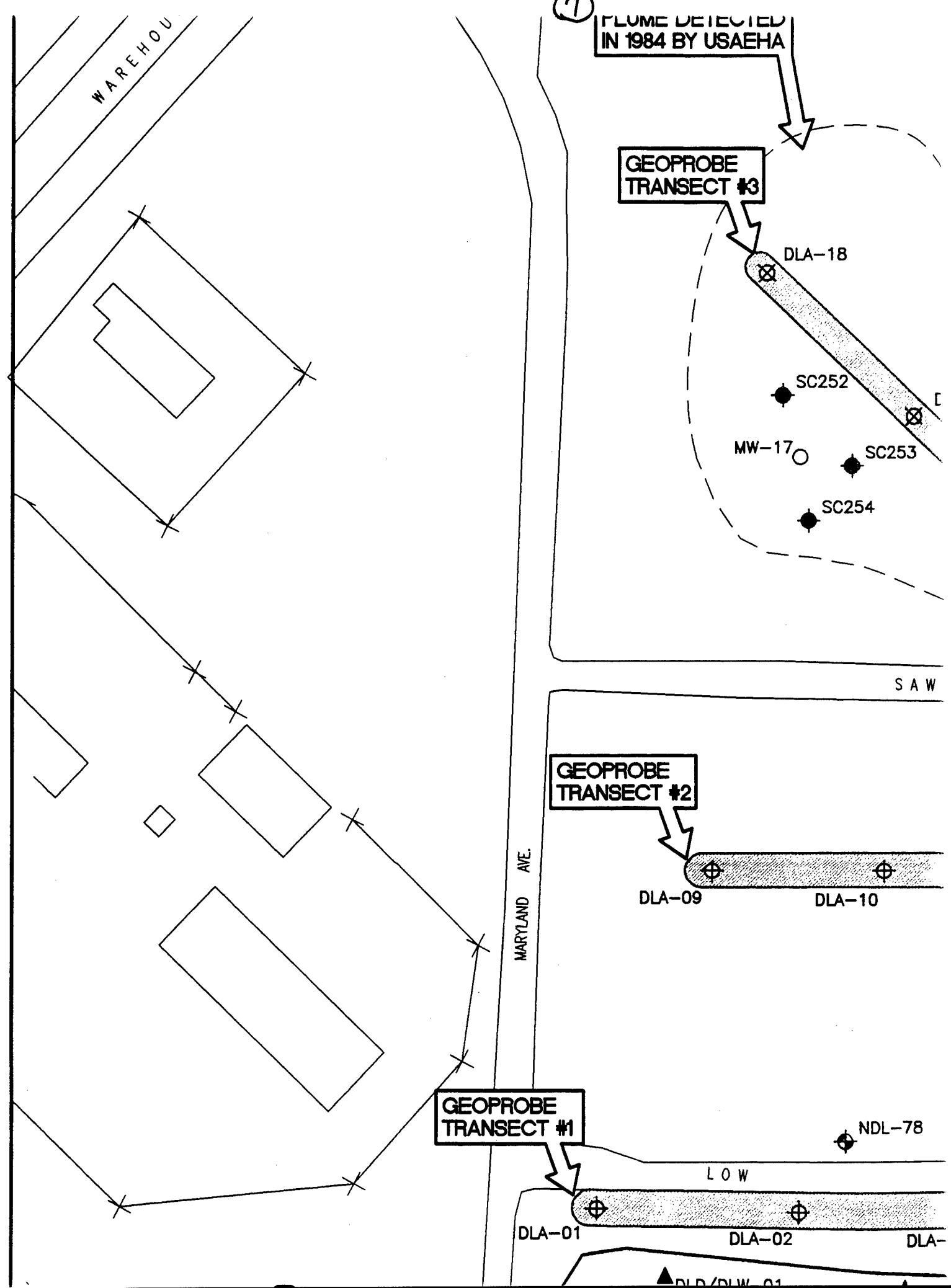
(6)



EEING SOIL BORINGS ARE APPROXIMATE AND WILL BE ADJUSTED BASED
ALYTICAL RESULTS.

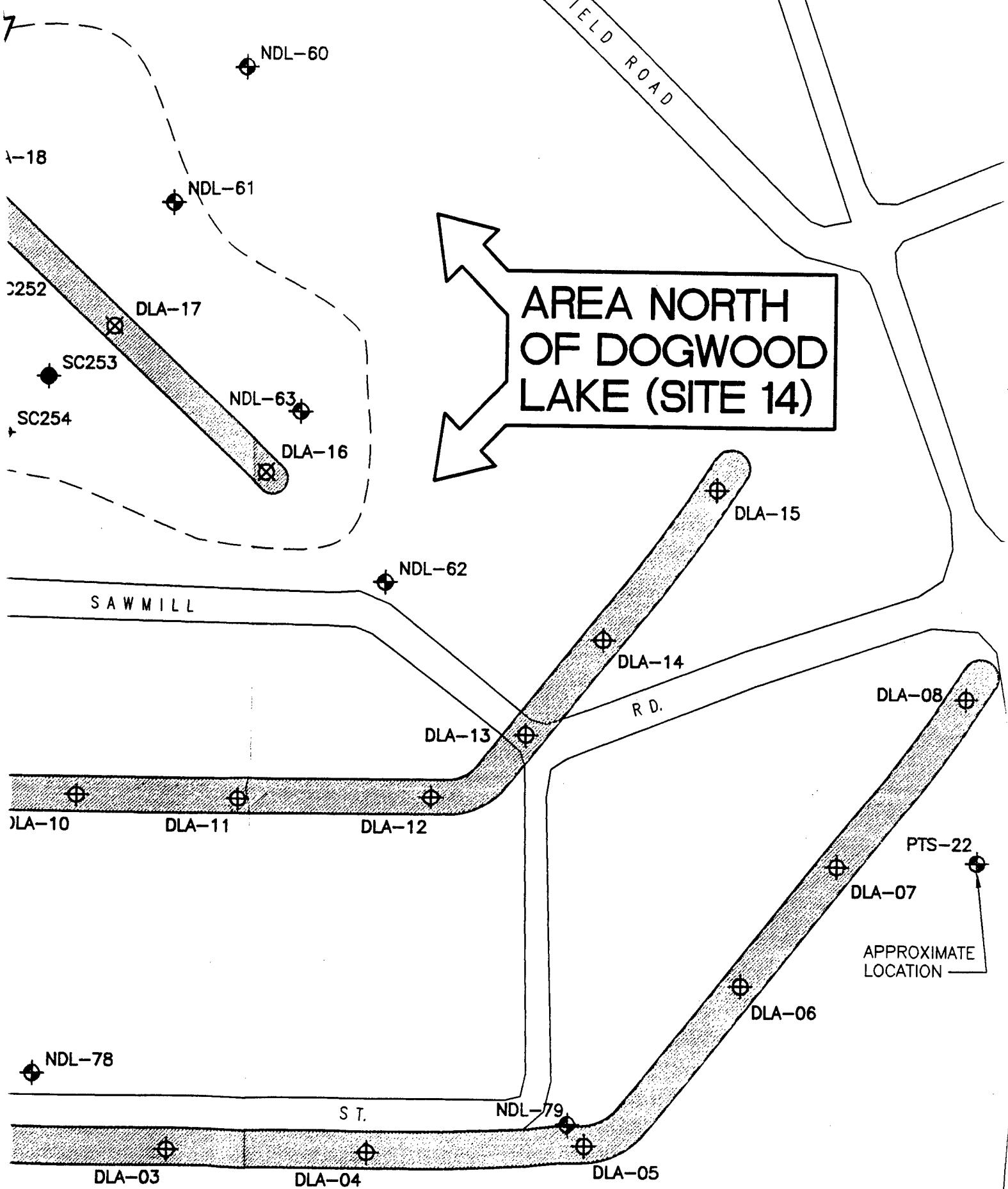
OF PROPOSED MONITORING WELLS (NOT SHOWN) WILL BE DETERMINED
FIELD SCREENING ANALYTICAL RESULTS. UP TO 6 ADDITIONAL MONITORING
) IF NECESSARY.

ATIONS WILL CONSIST OF 10 GEOPROBE /SCREENED AUGER EXPLORATIONS FOR GROUNDWATER

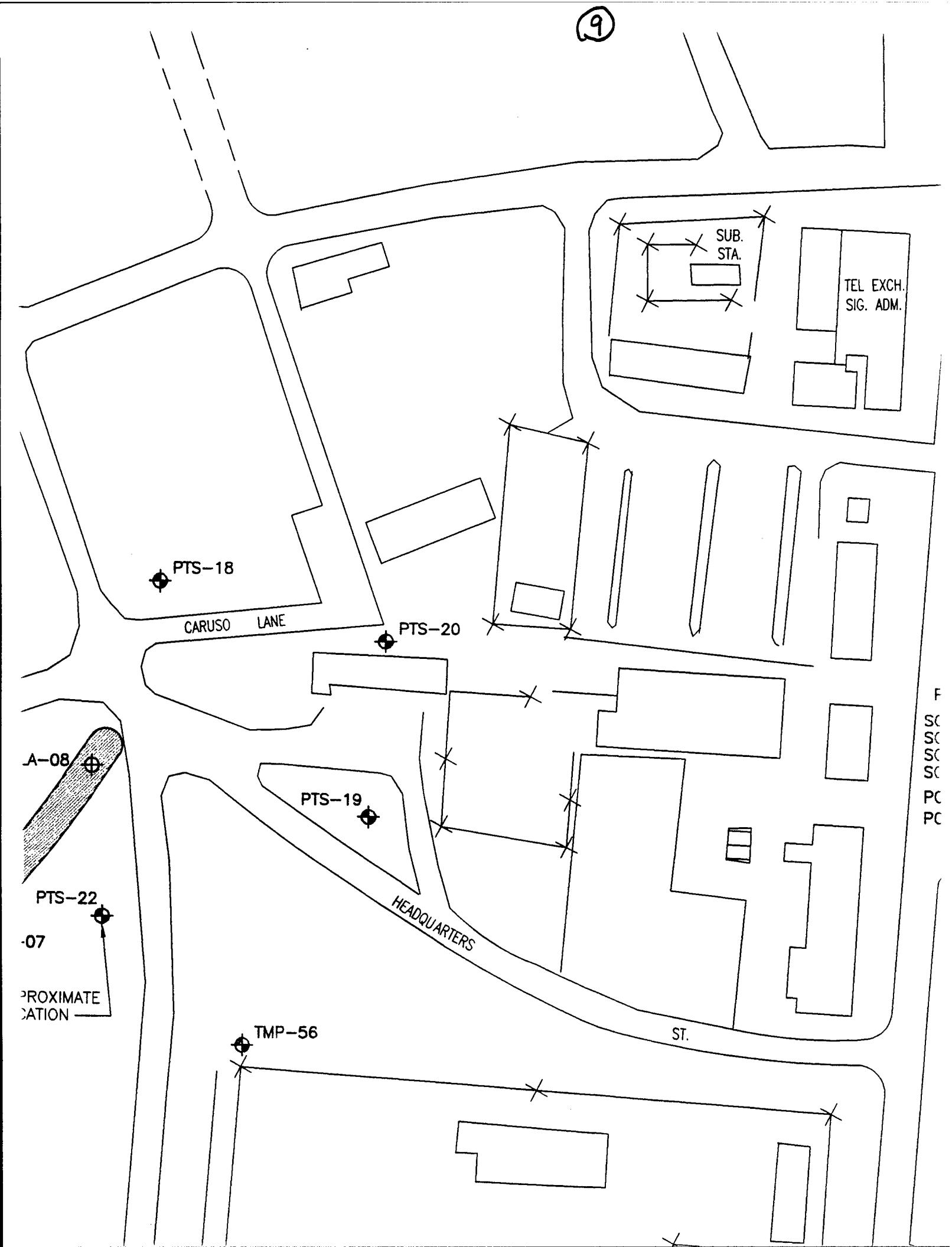


8

AIRFIELD ROAD



(9)



AIRFIELD

(1D)

TEL EXCH.
SIG. ADM.

SHOP

STORM
BASIN

PCA-03
PCB-05
PCB-04
PCB-03
SC-145
SC-146
SC-147
SC-212
PCA-01
PCB-01
SC-148
SC-149
SC-150
SC-211

GRAVEL PITS
PCB-08
PCB-06
PCB-07
PCA-05
PCA-02
PCA-04
PCA-06
PCA-08
PCA-07

**PESTICIDE
CONTROL
SHOP
(SITE 8)**

S. GARAGE RD.

FIRE
HOUSE

FTT-51
SC-124

R.D.

FENCE
BOUNDARY

(11)

SITE 3 NOTES:

1. LOCATIONS OF FIELD SCREENING SOIL BORINGS ARE APPROXIMATE AND WILL BE ADJUSTED BASED ON FIELD SCREENING ANALYTICAL RESULTS.
2. LOCATIONS AND NUMBER OF PROPOSED MONITORING WELLS (NOT SHOWN) WILL BE BASED ON SOIL BORING FIELD SCREENING ANALYTICAL RESULTS. UP TO 6 ADDITIONAL WELLS WILL BE INSTALLED IF NECESSARY.

SITE 5 NOTES:

1. FIELD SCREENING EXPLORATIONS WILL CONSIST OF 10 GEOPROBE/SCREENED AUGER AND 10 SOIL BORING EXPLORATIONS (TMB-01 THROUGH TMB-10) FOR SOIL. THE LOCATIONS AND NUMBER OF PROPOSED MONITORING WELLS (NOT SHOWN) WILL BE BASED ON FIELD SCREENING ANALYTICAL RESULTS.
2. LOCATIONS AND NUMBER OF PROPOSED MONITORING WELLS (NOT SHOWN) WILL BE BASED ON FIELD SCREENING SOIL AND GROUNDWATER ANALYTICAL RESULTS. UP TO 3 ADDITIONAL WELLS WILL BE INSTALLED IF NECESSARY.

SITE 8 NOTES:

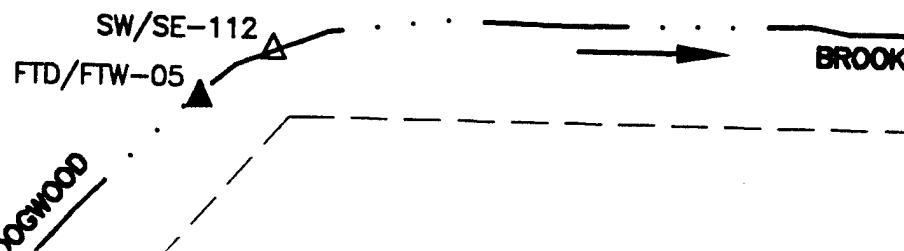
1. LOCATIONS OF FIELD SCREENING EXPLORATIONS (GEOPROBE/SCREENED AUGER AND SCREENED TRAJECTORY) ARE APPROXIMATE AND WILL BE ADJUSTED BASED ON FIELD SCREENING ANALYTICAL RESULTS.
2. LOCATIONS AND NUMBER OF PROPOSED MONITORING WELLS (NOT SHOWN) WILL BE BASED ON FIELD SCREENING ANALYTICAL RESULTS. UP TO 4 ADDITIONAL MONITORING WELLS WILL BE INSTALLED IF NECESSARY.

SITE 14 NOTES:

1. LOCATIONS AND NUMBER OF GEOPROBE/SCREENED AUGER TRANSECTS AND EXPLORATIONS WILL BE ADJUSTED BASED ON FIELD SCREENING ANALYTICAL RESULTS.
2. LOCATIONS AND NUMBER OF PROPOSED MONITORING WELLS (NOT SHOWN) WILL BE BASED ON GROUNDWATER FIELD SCREENING ANALYTICAL RESULTS. UP TO 4 ADDITIONAL MONITORING WELLS WILL BE INSTALLED IF NECESSARY.

GENERAL NOTES:

1. LOCATIONS OF ALL EXISTING INVESTIGATIONS ARE APPROXIMATE.
2. CAD BASE MAP SOURCE: FORT DIX
3. TPH = TOTAL PETROLEUM HYDROCARBONS
4. USAEHA = UNITED STATES ARMY ENVIRONMENTAL HYGIENE AGENCY



FENCE
BOUNDARY

ENING SOIL BORINGS ARE APPROXIMATE AND WILL BE ADJUSTED BASED
YTICAL RESULTS.

F PROPOSED MONITORING WELLS (NOT SHOWN) WILL BE DETERMINED
ELD SCREENING ANALYTICAL RESULTS. UP TO 6 ADDITIONAL MONITORING
IF NECESSARY.

TIONS WILL CONSIST OF 10 GEOPROBE/SCREENED AUGER EXPLORATIONS FOR GROUNDWATER
ORATIONS (TMB-01 THROUGH TMB-10) FOR SOIL. THE NUMBER OF EXPLORATIONS WILL BE
SCREENING ANALYTICAL RESULTS.

E PROPOSED MONITORING WELLS (NOT SHOWN) WILL BE DETERMINED BASED
AND GROUNDWATER ANALYTICAL RESULTS. UP TO 3 ADDITIONAL MONITORING
IF NECESSARY.

NING EXPLORATIONS (GEOPROBE/SCREENED AUGER AND SOIL BORING) ARE
ADJUSTED BASED ON FIELD SCREENING ANALYTICAL RESULTS.

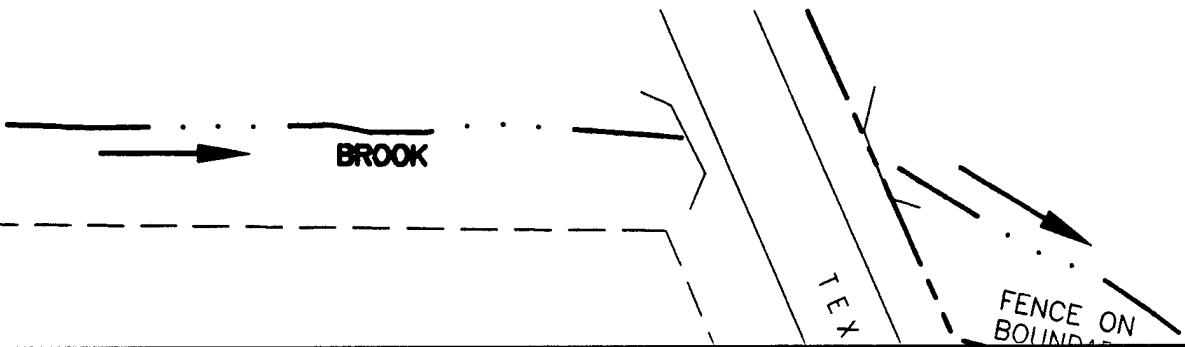
E PROPOSED MONITORING WELLS (NOT SHOWN) WILL BE DETERMINED BASED
YTICAL RESULTS. UP TO 4 ADDITIONAL MONITORING WELLS WILL BE INSTALLED

GEOPROBE/SCREENED AUGER TRANSECTS AND EXPLORATIONS ARE APPROXIMATE AND
ON FIELD SCREENING ANALYTICAL RESULTS.

PROPOSED MONITORING WELLS (NOT SHOWH) WILL BE DETERMINED BASED ON
NING ANALYTICAL RESULTS. UP TO 4 ADDITIONAL MONITORING WELLS WILL BE

INVESTIGATIONS ARE APPROXIMATE.
RT DIX
YDROCARBONS

ARMY ENVIRONMENTAL HYGIENE AGENCY



13

DLA-US

DLA-TU

MARYLAND

**GEOPROBE
TRANSECT #1**

NDL-78

LOW

DLA-01

DLA-02

DLA-

▲ DLD/DLW-01

▲ DLD,

SW/SE-117 △

NORTH PLAZA

-10

DLA-11

DLA-12

14

PTS-22

DLA-07

APPROXIMATE
LOCATION

NDL-78

S T.

NDL-79

DLA-03

DLA-04

DLA-05

▲ DLD/DLW-02

* DLSTAFF1

△ SW/SE-118

DOGWOOD
LAKE

ZA

SW/SE-119

SPILLWAY

SW/SE-109

PENNSYLVANIA AVENUE

PTS-22

17

PROXIMATE
LOCATION

HEADQUARTERS

15

ST.

TMP-56

**TRANSPORTATION
MOTOR POOL
(SITE 5)**

TMP-54

PENNSYLVANIA AVENUE

DELAWARE AVENUE

**PROPOSED AREA
OF FIELD SCREENING
EXPLORATIONS**

BURIED CULVERT/
STORM SEWER

TMS-01

TMS-02

NAY
SW/SE-109

17

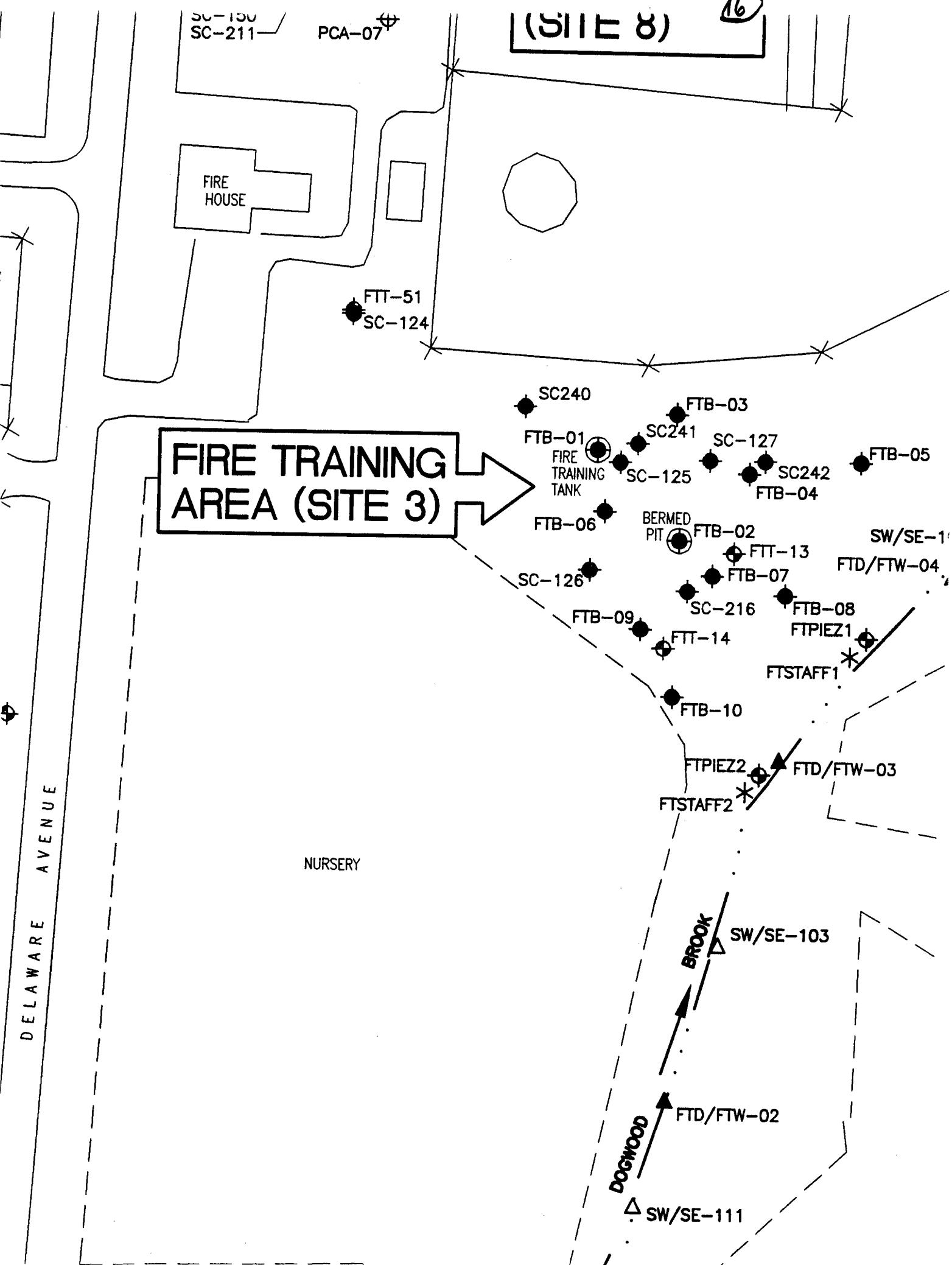
SC-150
SC-211

PCA-07

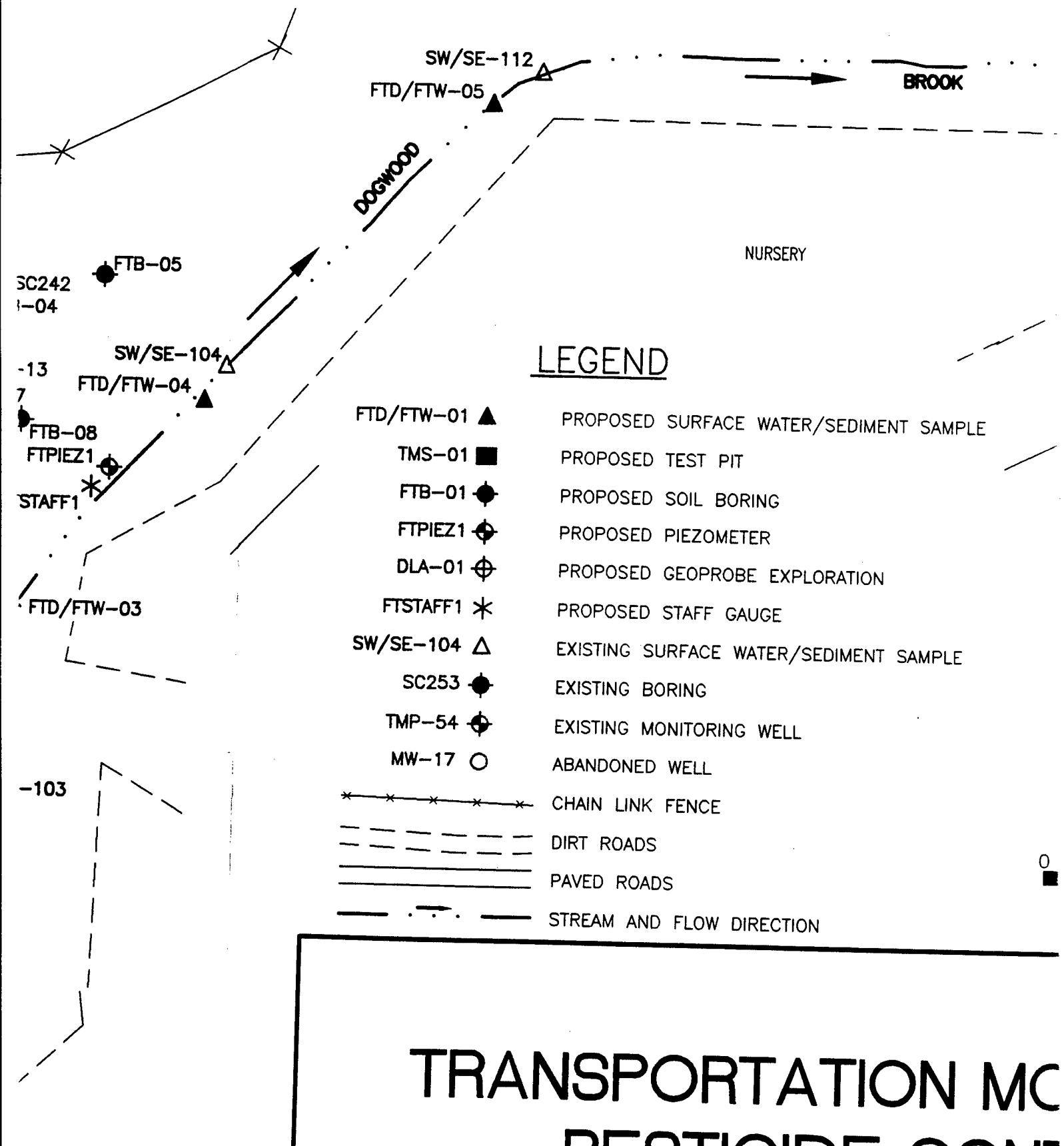
(SITE 8)

16

**FIRE TRAINING
AREA (SITE 3)**



1. LOCATIONS OF ALL EXISTING INVESTIGATIONS ARE APPROXIMATE.
2. CAD BASE MAP SOURCE: FORT DIX
3. TPH = TOTAL PETROLEUM HYDROCARBONS
4. USAEHA = UNITED STATES ARMY ENVIRONMENTAL HYGIENE AGENCY



INVESTIGATIONS ARE APPROXIMATE.
 DRT DIX
 HYDROCARBONS
 ARMY ENVIRONMENTAL HYGIENE AGENCY

NURSERY

D

SURFACE WATER/SEDIMENT SAMPLE

TEST PIT

SOIL BORING

PIEZOMETER

GEOPROBE EXPLORATION

STAFF GAUGE

SURFACE WATER/SEDIMENT SAMPLE

DRING

MONITORING WELL

WELL

FENCE

S

FLOW DIRECTION

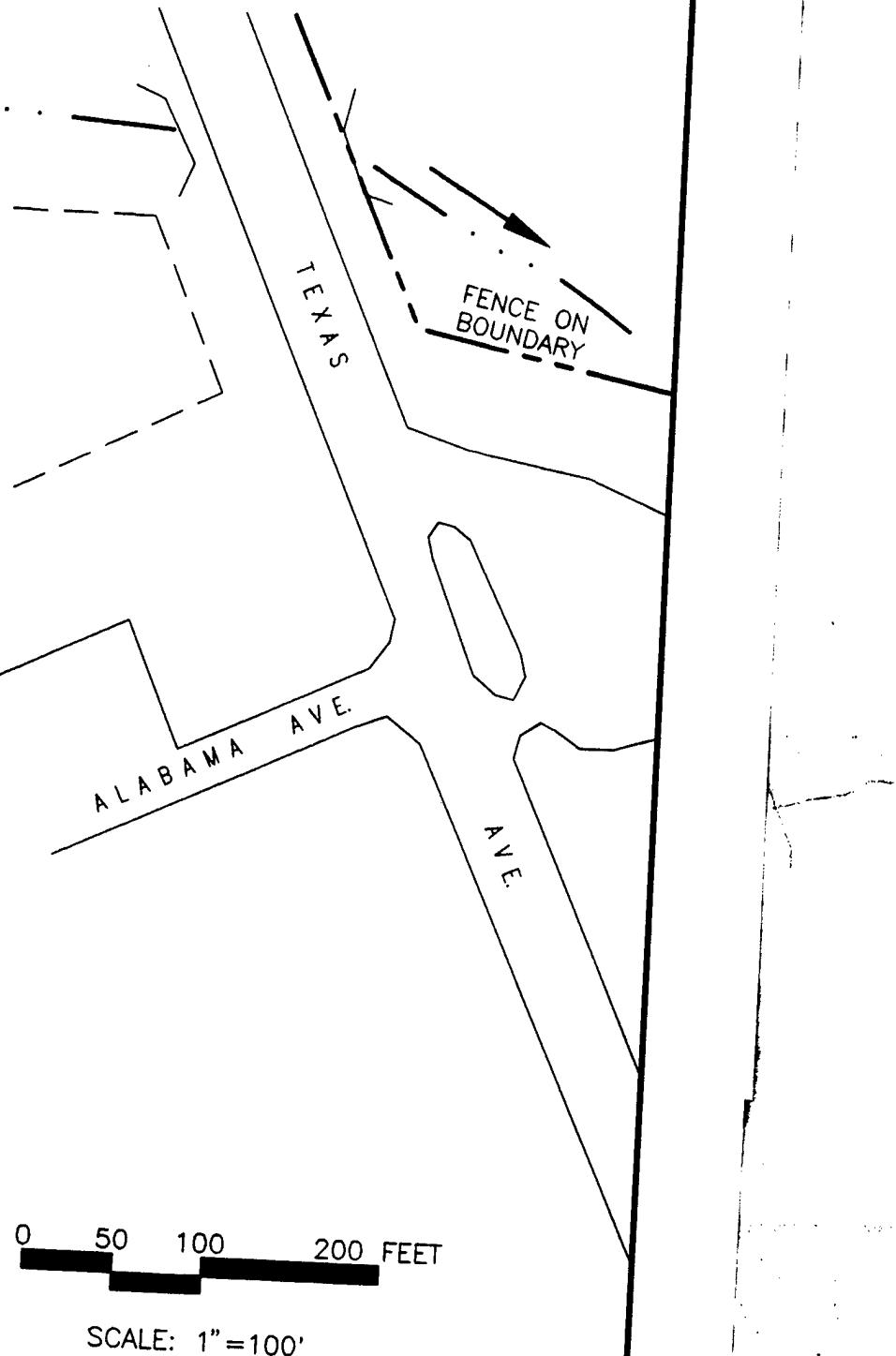
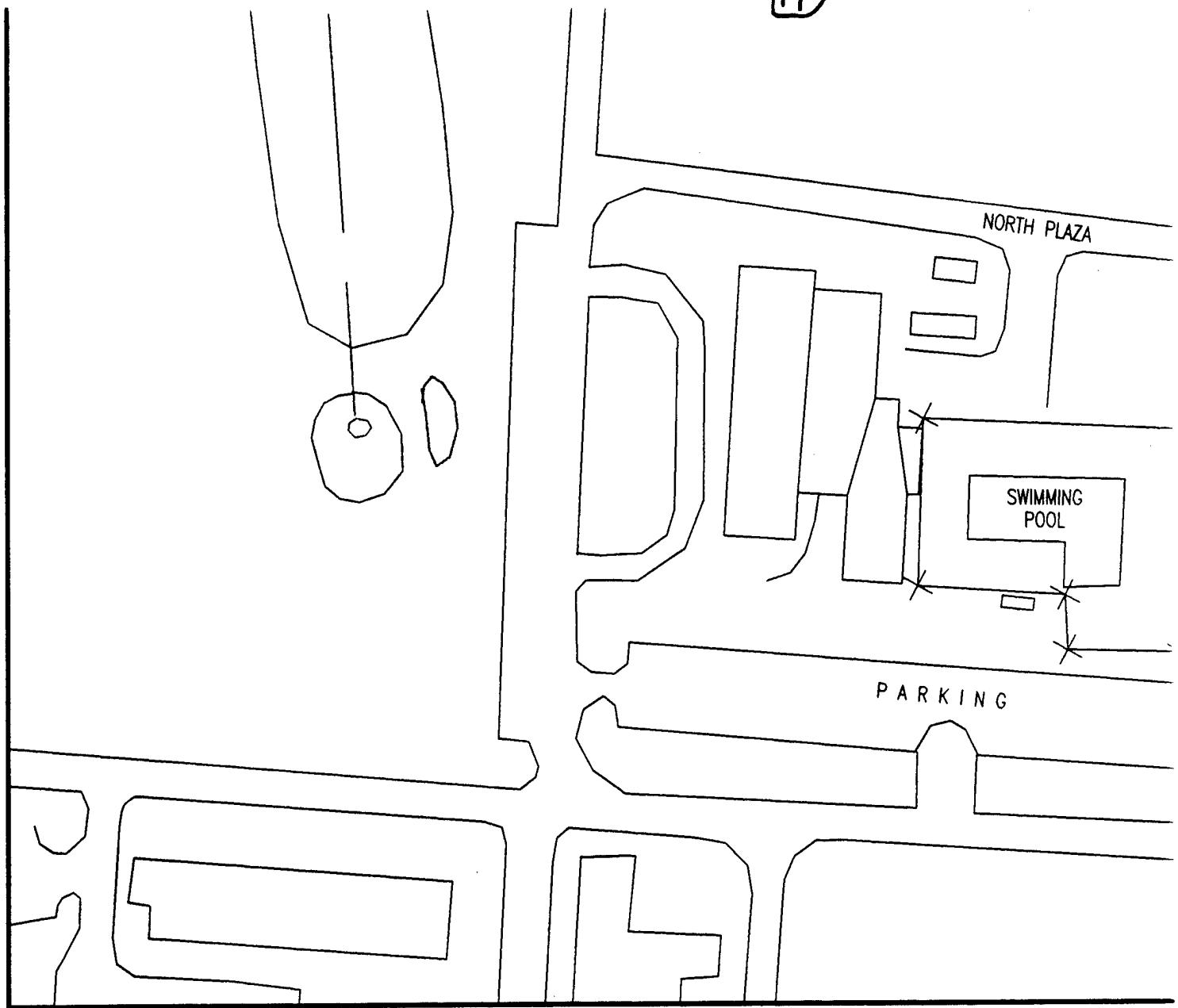


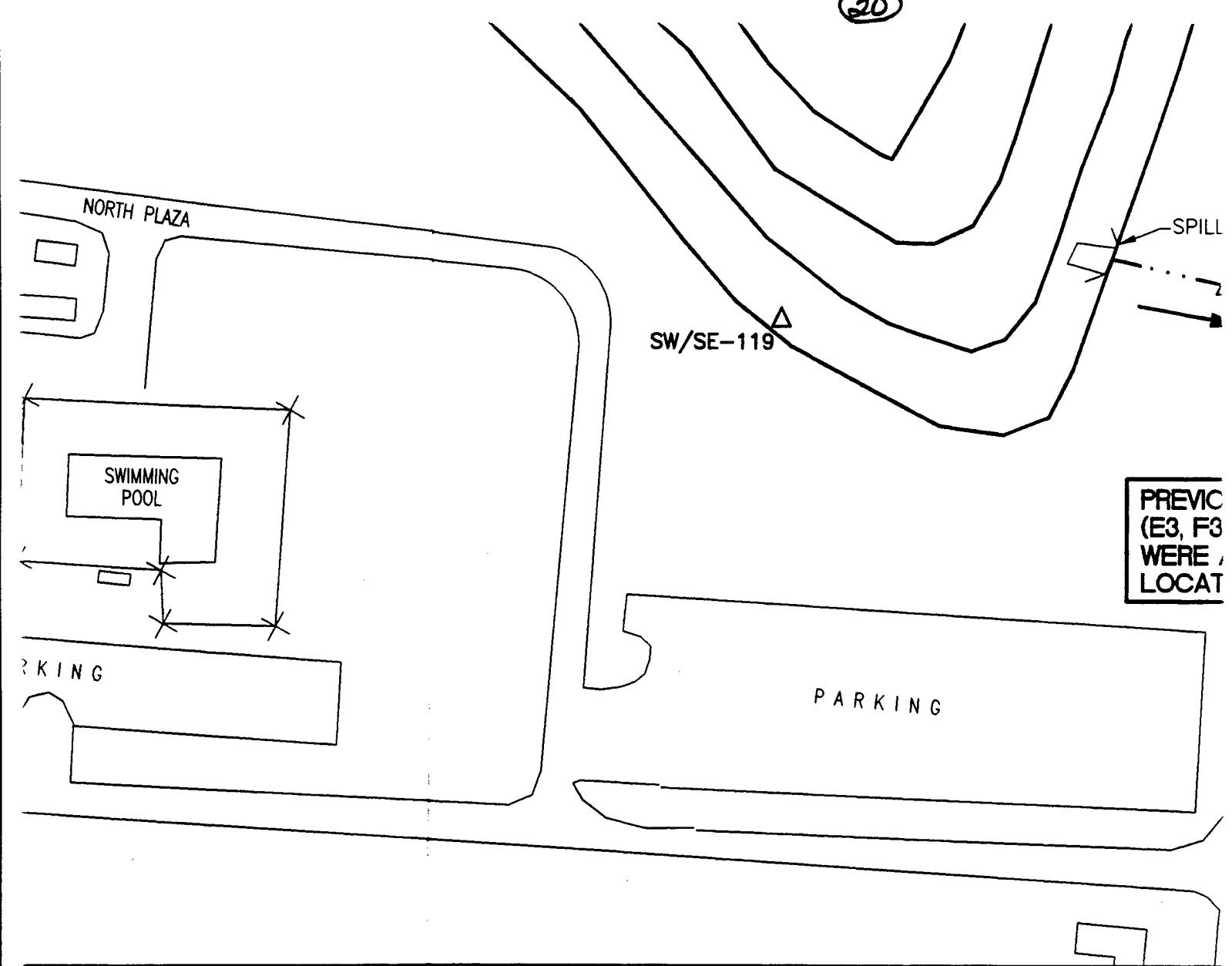
FIGURE 7

CERTIFICATION MOTOR POOL,
Pesticide Control

(19)



620



PROPOSED AREA
OF FIELD SCREENING
EXPLORATIONS

SPILLWAY
SW/SE-109

BURIED CULVERT/
STORM SEWER

PREVIOUS BORINGS
(E3, F3, G3 AND H3)
WERE APPARENTLY
LOCATED IN THIS AREA

TMS-01

TMS-02

TMS-03

TMP-21

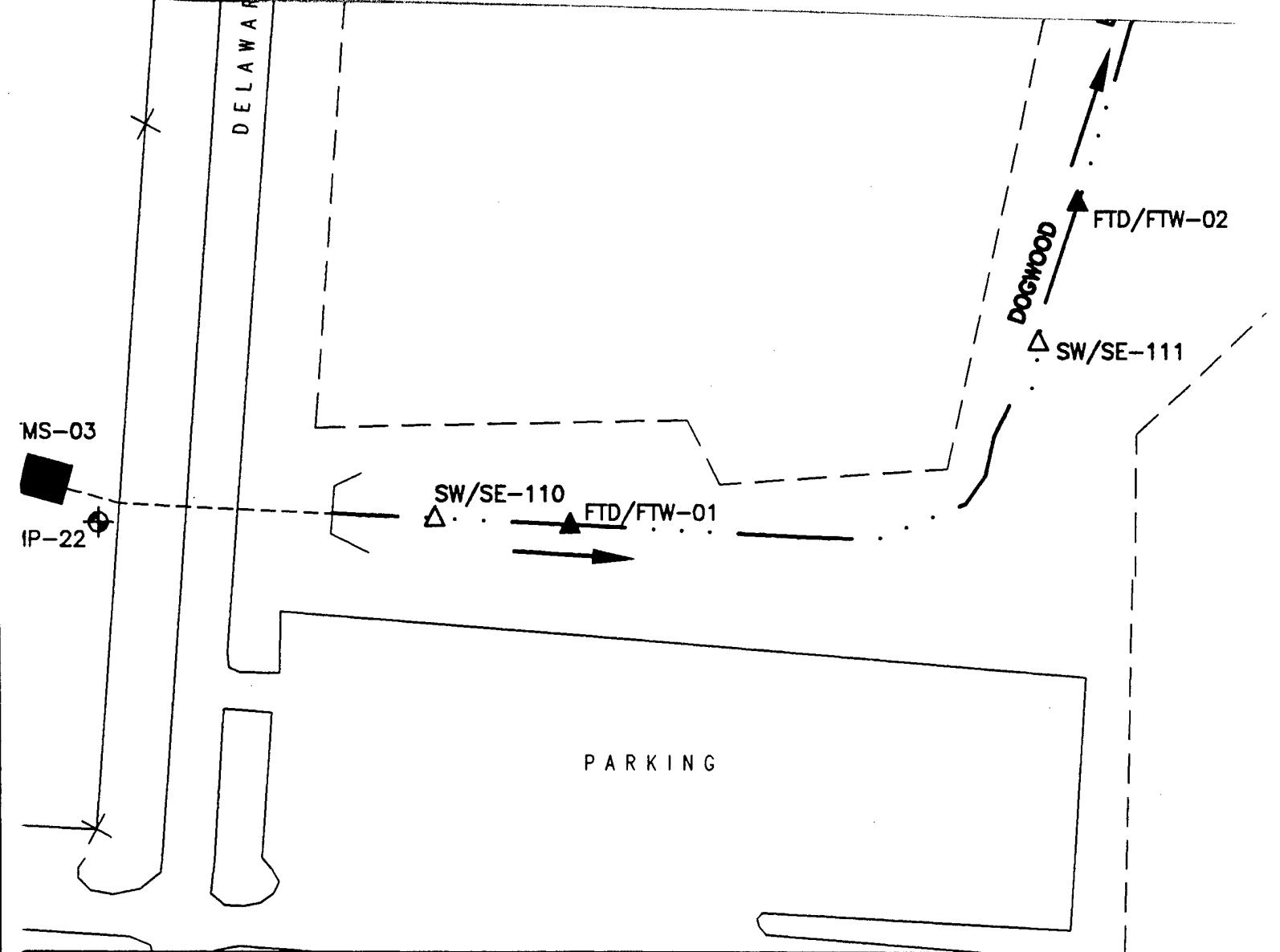
TMP-22

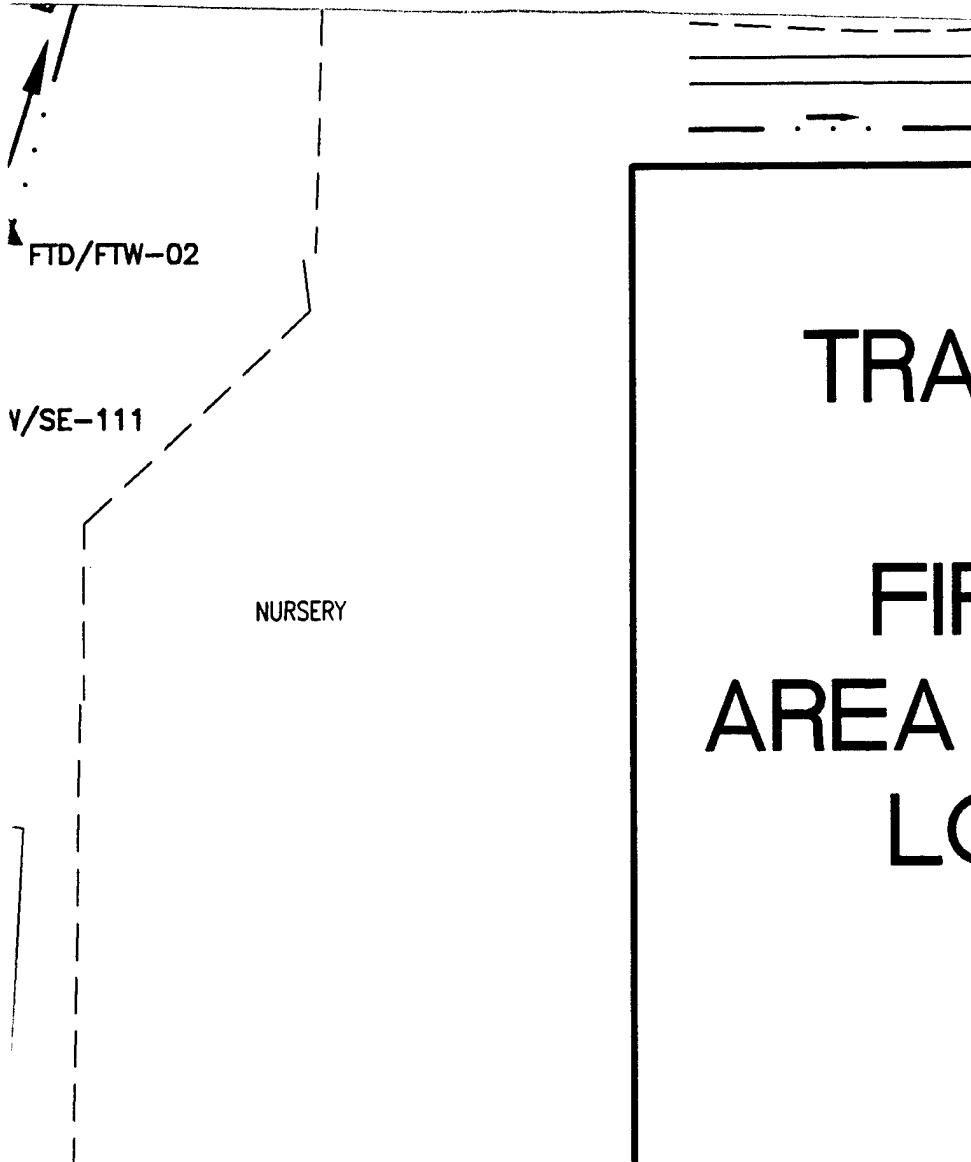
TMP-23

TMP-55

WEST FIRST STREET

(22)





PAVED ROADS

STREAM AND FLOW DIRECTION

FTD/FTW-02

V/SE-111

NURSERY

**TRANSPORTATION
PESTICIDE
FIRE TRAINING
AREA NORTH OF C
LOCATIONS OF
PROPOSED
FORT DIX RI/I
ABB Environ**

PAVED ROADS

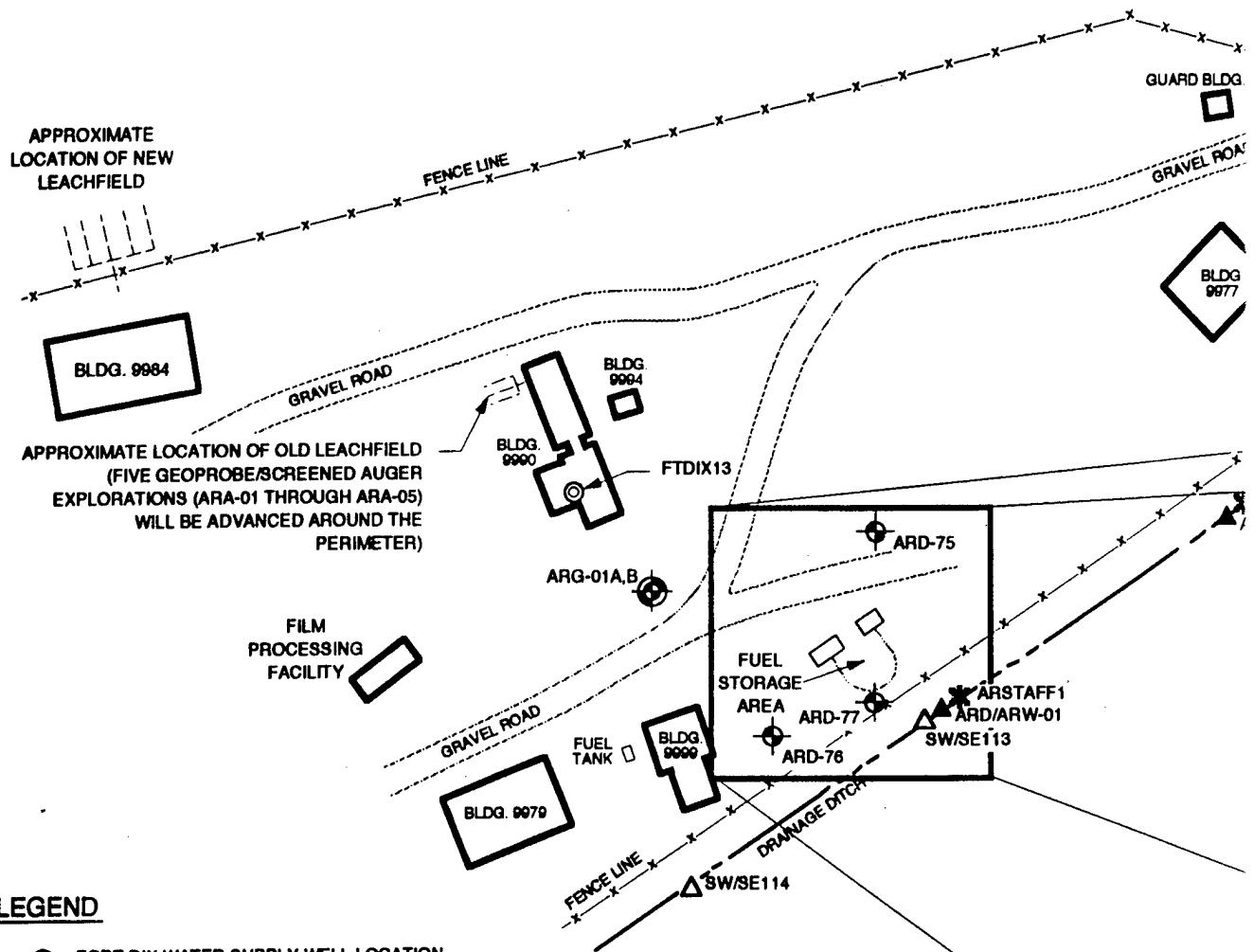
STREAM AND FLOW DIRECTION

SCALE: 1"=100'

FIGURE 7
NSPORTATION MOTOR POOL,
PESTICIDE CONTROL SHOP,
THE TRAINING TANK AREA AND
NORTH OF DOGWOOD LAKE
LOCATIONS OF EXISTING AND
PROPOSED INVESTIGATIONS
FORT DIX RI/FS FOR 13 SITES
— ABB Environmental Services, Inc. —

N

1



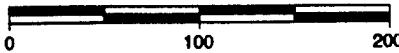
LEGEND

- FTDIX13 (circle) FORT DIX WATER SUPPLY WELL LOCATION
- ARD-75 (circle) EXISTING MONITORING WELL LOCATION
- SC-130 (circle) EXISTING SOIL BORING SAMPLE LOCATION
- SW/SE-113 (triangle) EXISTING SURFACE WATER/SEDIMENT SAMPLE LOCATION
- ARG-01A,B (circle) PROPOSED MONITORING WELL NEST LOCATION
- ARB-01 (circle) PROPOSED SOIL BORING SAMPLE LOCATION
- ARS-07 (square) PROPOSED SURFACE SOIL SAMPLE LOCATION
- ARD/ARW-01 (triangle) PROPOSED SURFACE WATER/SEDIMENT SAMPLE LOCATION
- ARSTAFF2 (asterisk) PROPOSED SURFACE WATER STAFF GAUGE

NOTES: 1. OPTIONAL SURFACE WATER/SEDIMENT SAMPLE PAIRS ARD/ARW-04 THROUGH ARD/ARW-08 WILL BE LOCATED AS NEEDED, BASED ON FIELD SCREENING RESULTS FROM ARD/ARW-01 THROUGH ARD/ARW-03.

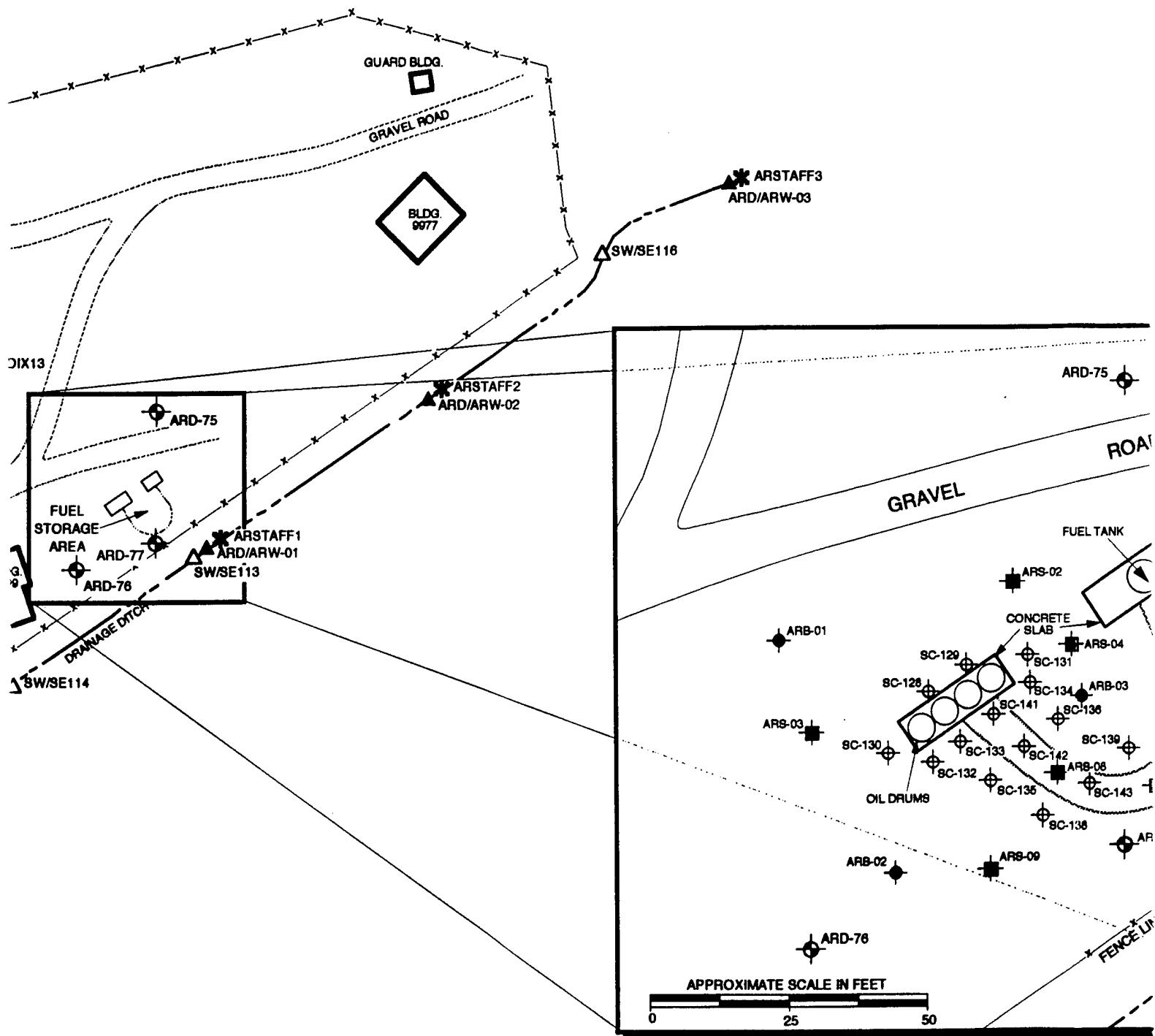
2. LOCATIONS OF EXPLORATIONS ARE APPROXIMATE AND MAY BE ADJUSTED BASED ON FIELD CONDITIONS.

APPROXIMATE SCALE IN FEET



SOURCE: DAMES & MOORE, 1993.

2



LOCATIONS OF EXISTING

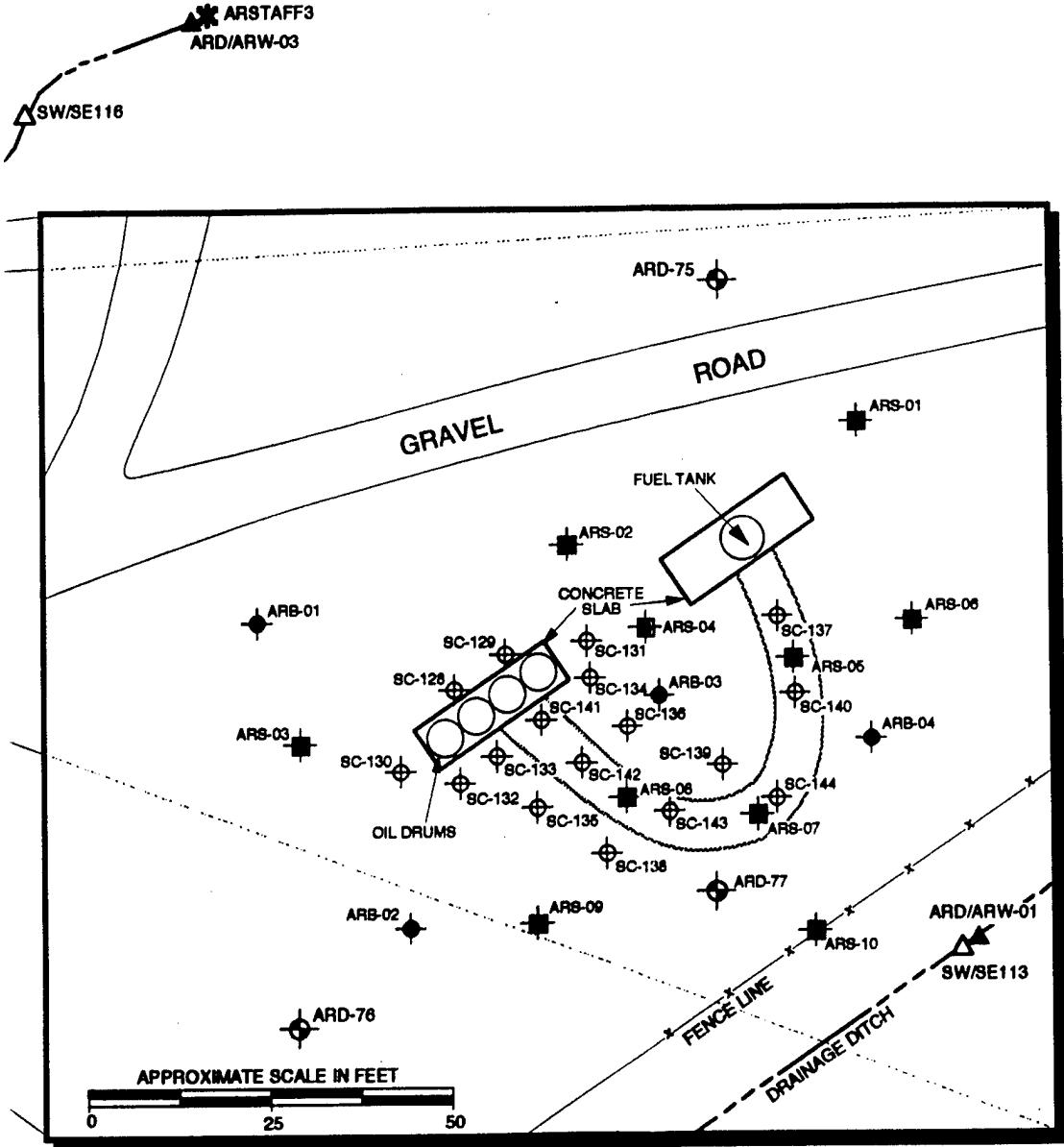
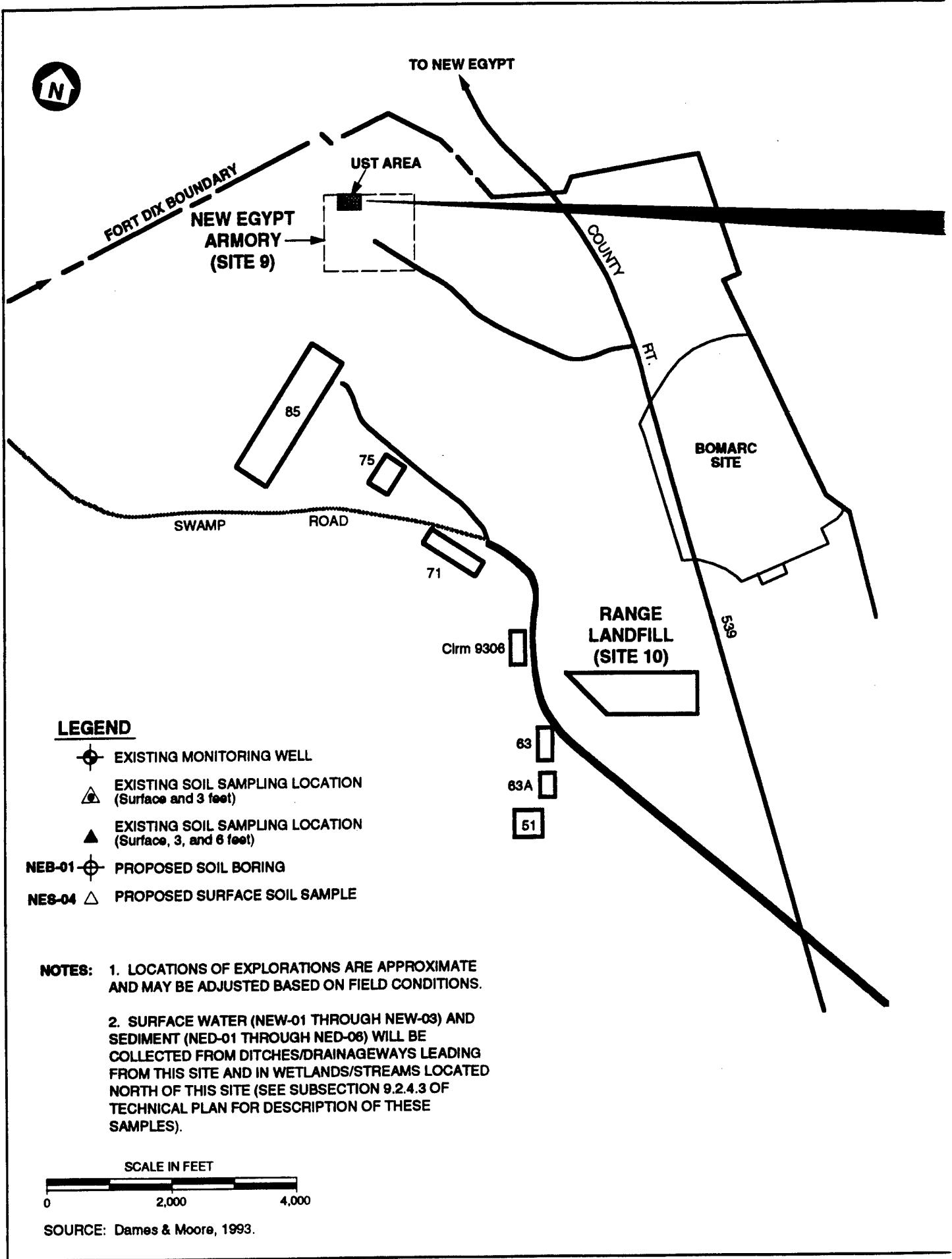


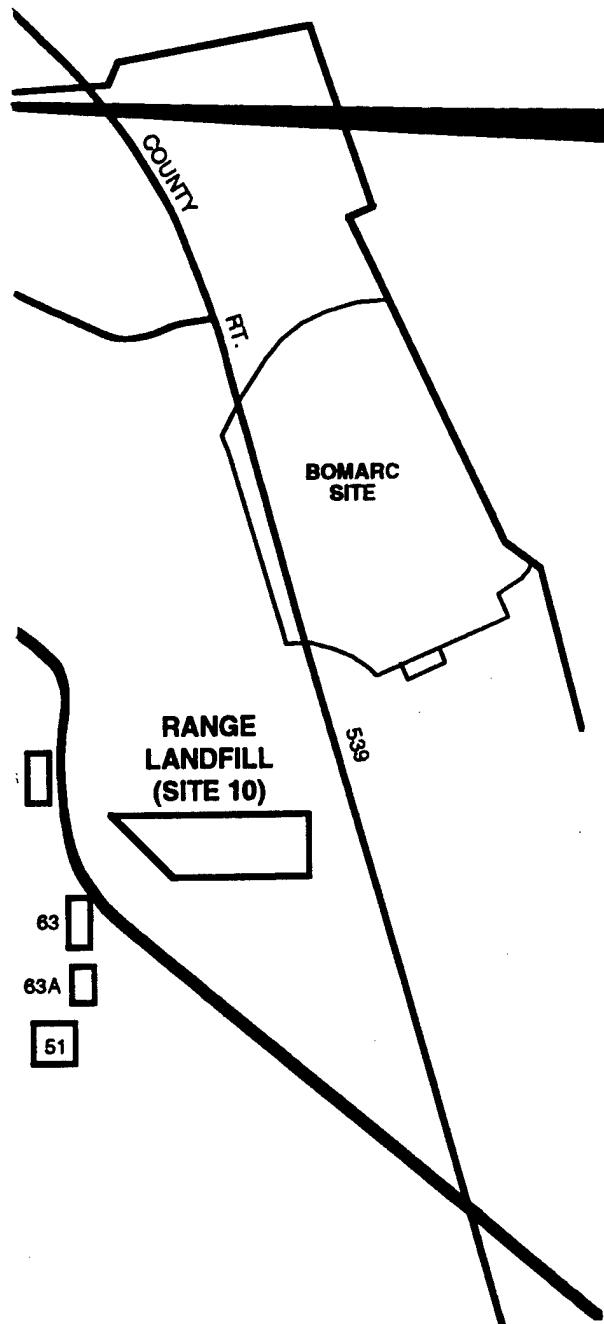
FIGURE 8
ARDC TEST FACILITY
LOCATIONS OF EXISTING AND PROPOSED INVESTIGATIONS
TECHNICAL PLAN
FORT DIX RVFS FOR 13 SITES

ABB Environmental Services, Inc.



2

ג



△ NES-07

△ NES-06

NES-08

NEA-58

△ NES-0

△ NES-04

NEA-59

NEA-56

IEB-07 159

160

161

NE-09

△ 162

163

▲ 169

164

NEB-08

160

170

166

△ NES-10

BREAK IN SLOPE

NOT TO SCALE

 NEA-57

LOCATIONS OF EXISTI

△ NES-07

△ NES-06

△ NES-08

△ NES-05 △ NES-04

NEA-58

NEB-08 NEB-09

157 158

NEA-59

NEB-07 159

160 161

△ NES-03

△ 162

163

169

164

△ NES-02

NEB-06

165

170

166

△ NES-01

△ NES-10

167

171

168

NEB-05

BREAK IN SLOPE

NEB-04
NEB-02
NEB-01
NEB-03

TWO USTs

CALE NEA-57

FIGURE 9
NEW EGYPT ARMORY
LOCATIONS OF EXISTING AND PROPOSED INVESTIGATIONS
TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES
 ABB Environmental Services, Inc.

NOTES:

1. Prior to locating new explorations in the field, location and identification of existing wells will be confirmed, and a groundwater contour map will be produced from existing wells to define groundwater flow directions.
2. Up to seven screened auger/geoprobe explorations (RLA-01 through RLA-07) for groundwater field screening will be conducted around the perimeter of the landfill. The locations will be determined once well identification and groundwater flow direction have been confirmed.
3. Up to five monitoring wells will be installed based upon field screening analytical results.

N

RANGE
LANDFILL
(SITE 10)

RLF-27

RLF-30 RLF-29

539

63

63A

51

LEGEND

RLF-30 • EXISTING MONITORING WELL

APPROXIMATE
SCALE IN FEET

0 1,000 2,000

SOURCE: Dames & Moore, 1993.

9310021D(d),2

FIGURE 10
RANGE LANDFILL
LOCATIONS OF EXISTING AND
PROPOSED INVESTIGATIONS
TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

ABB Environmental Services, Inc.

(1)

PEMBERTON POINTVILLE RD.

WES-3

NOTES:

1. APPROXIMATE SITE BOUNDARY UPON AERIAL PHOTO INTERPR
2. TEST PIT LOCATIONS ARE APP
MAY BE ADJUSTED BASED ON
3. CAD BASE MAP SOURCE: FOR

APPROXIMATE SITE BOUNDARY (1940) —

APPROXIMATE GEOPHYSICAL SURVEY BOUNDARIES —

LEGEND

A9S-01 ■ PROPOSED TEST PIT

AN9-38 • EXISTING MONITORING WELL

— — — DIRT ROADS

— — — PAVED ROADS

— - - - SITE BOUNDARY

..... GEOPHYSICAL SURVEY BOUNDARY

0 50 100 200 FEET

SCALE: 1"=100'

NOTES:

1. APPROXIMATE SITE BOUNDARY IS BASED UPON AERIAL PHOTO INTERPRETATION.
2. TEST PIT LOCATIONS ARE APPROXIMATE AND MAY BE ADJUSTED BASED ON FIELD CONDITIONS.
3. CAD BASE MAP SOURCE: FORT DIX

ANC-9
(SITE 11)

APPROXIMATE SITE BOUNDARY (1940)

APPROXIMATE GEOPHYSICAL SURVEY BOUNDARIES

LINEAR TRENCH PHOTO

A9S-05

A9S-04

A9S-01

A9S-02

A9S-03

AN9-39

ILLIUSTOWN RD.

(3)



**ANC-9
(SITE 11)**

LINEAR GROUND SCARS AND POSSIBLE
TRENCHES IDENTIFIED FROM AERIAL
PHOTOGRAPHS (1940 AND 1951)

AN9-39

A9S-04

A9S-01

A9S-02

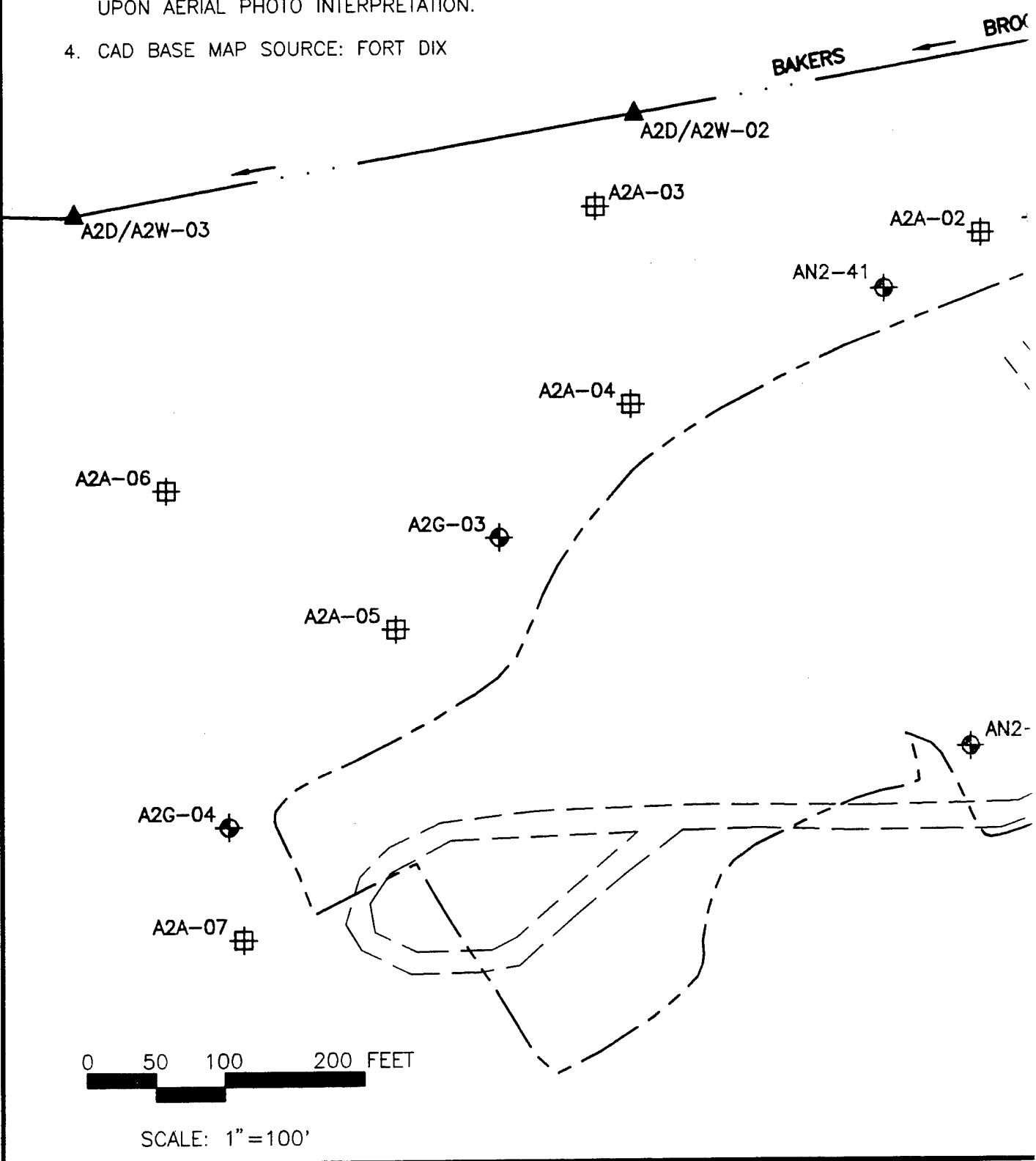
A9S-03

AN9-38

FIGURE 11
ANC-9 LANDFILL
LOCATIONS OF EXISTING AND
PROPOSED INVESTIGATIONS
FORT DIX RI/FS FOR 13 SITES

NOTES:

1. LOCATIONS OF SCREENED AUGER BORINGS ARE APPROXIMATE AND SUBJECT TO CHANGE BASED ON DRILL RIG ACCESS AND FIELD SCREENING ANALYTICAL RESULTS.
2. PROPOSED EXPLORATION LOCATIONS ARE APPROXIMATE; FINAL LOCATIONS AND NUMBERS WILL BE DETERMINED BASED ON FIELD SCREENING ANALYTICAL RESULTS.
3. APPROXIMATE SITE BOUNDARY IS BASED UPON AERIAL PHOTO INTERPRETATION.
4. CAD BASE MAP SOURCE: FORT DIX





2

AN2-41

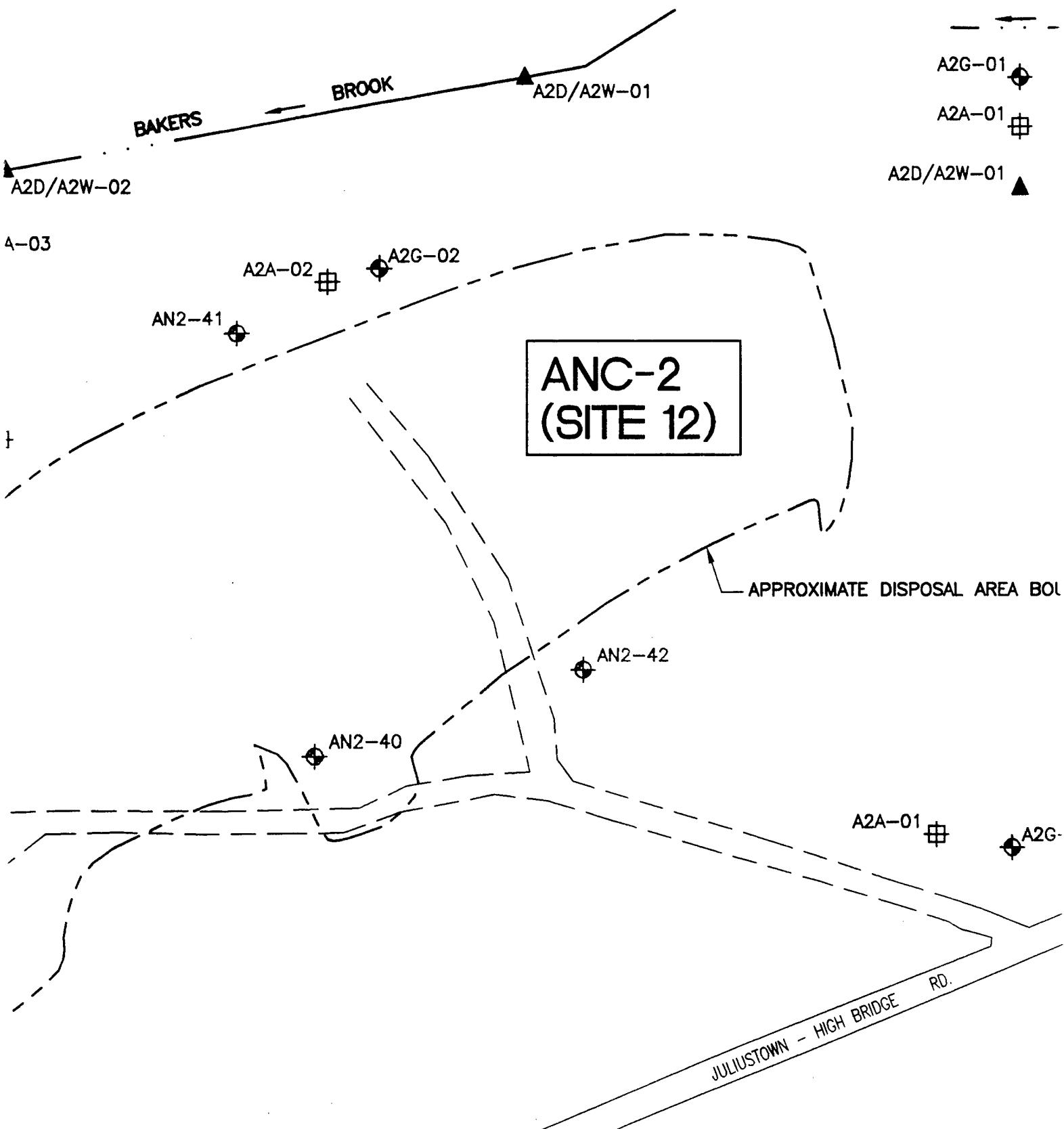
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=====

A2G-01

A2A-01

A2D/A2W-01



LEGEND

AN2-41	EXISTING MONITORING WELL
=====	DIRT ROADS
=====	PAVED ROADS
-----	DISPOSAL AREA BOUNDARY
- - - - -	STREAM AND FLOW DIRECTION
A2G-01	PROPOSED MONITORING WELL LOCATION
A2A-01	PROPOSED SCREENED AUGER BORING LOCATION
A2D/A2W-01	PROPOSED SURFACE WATER/SEDIMENT SAMPLE

**ANC-2
(SITE 12)**

APPROXIMATE DISPOSAL AREA BOUNDARY (1951)

AN2-42

A2A-01

A2G-01

JULIUSTOWN - HIGH BRIDGE RD.

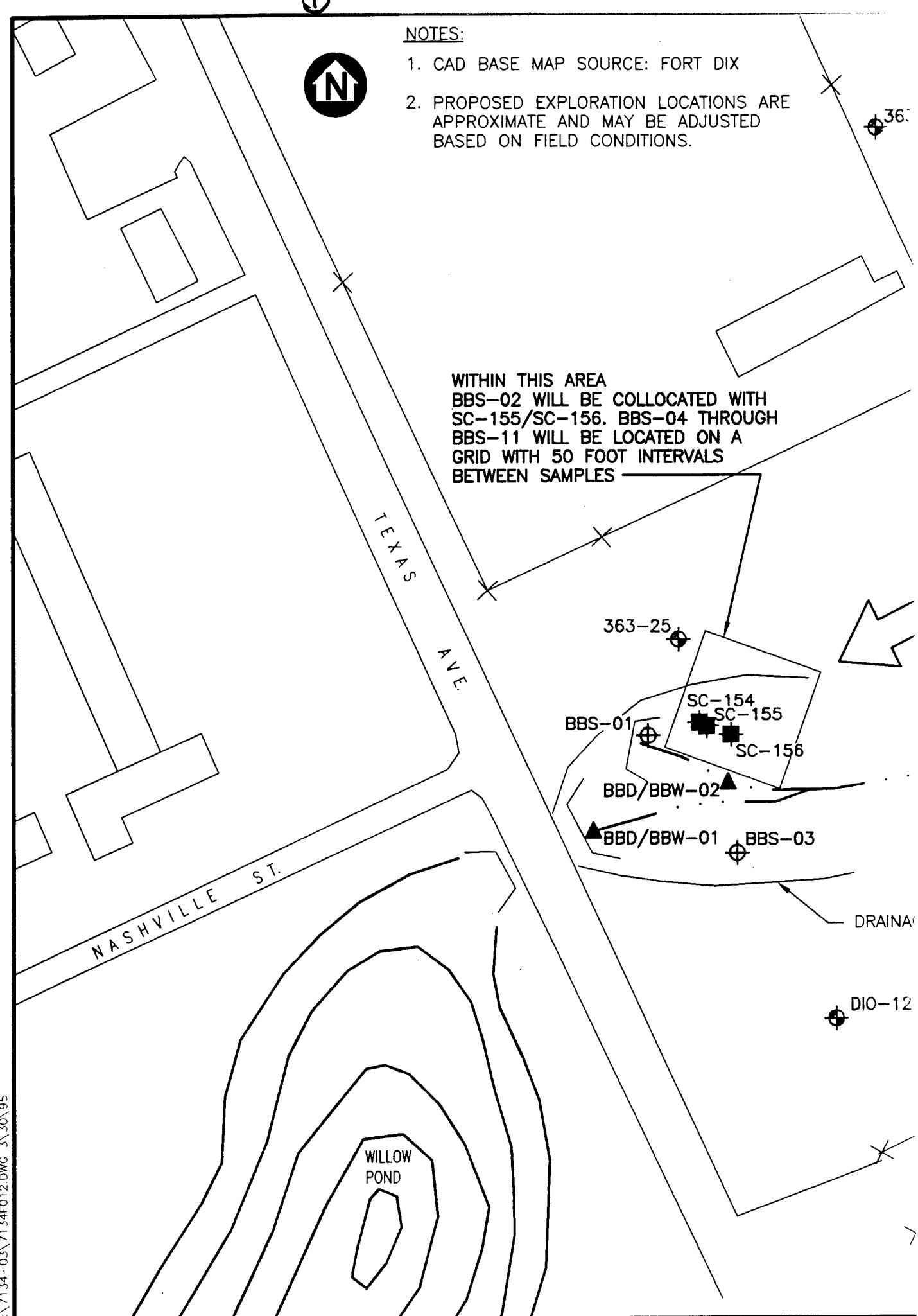
FIGURE 12
ANC-2 DISPOSAL AREA
LOCATIONS OF EXISTING AND
PROPOSED INVESTIGATIONS
FORT DIX RI/FS FOR 13 SITES

NOTES:

1. CAD BASE MAP SOURCE: FORT DIX
2. PROPOSED EXPLORATION LOCATIONS ARE APPROXIMATE AND MAY BE ADJUSTED BASED ON FIELD CONDITIONS.



WITHIN THIS AREA
BBS-02 WILL BE COLLOCATED WITH
SC-155/SC-156. BBS-04 THROUGH
BBS-11 WILL BE LOCATED ON A
GRID WITH 50 FOOT INTERVALS
BETWEEN SAMPLES



MAP SOURCE: FORT DIX

EXPLORATION LOCATIONS ARE
ESTIMATE AND MAY BE ADJUSTED
FIELD CONDITIONS.

THIS AREA
WILL BE COLLOCATED WITH
SC-156. BBS-04 THROUGH
BBS-08 WILL BE LOCATED ON A
50 FOOT INTERVALS
SAMPLES

(2)

363-24

SLUDGE
BEDS

363-26

BOILER BLOWDOWN AREA (SITE 13)

BBS-01

SC-154

SC-155

SC-156

BBD/BBW-02

BBD/BBW-01

BBS-03

BBD/BBW-03

DIO-11

DRAINAGE SWALE

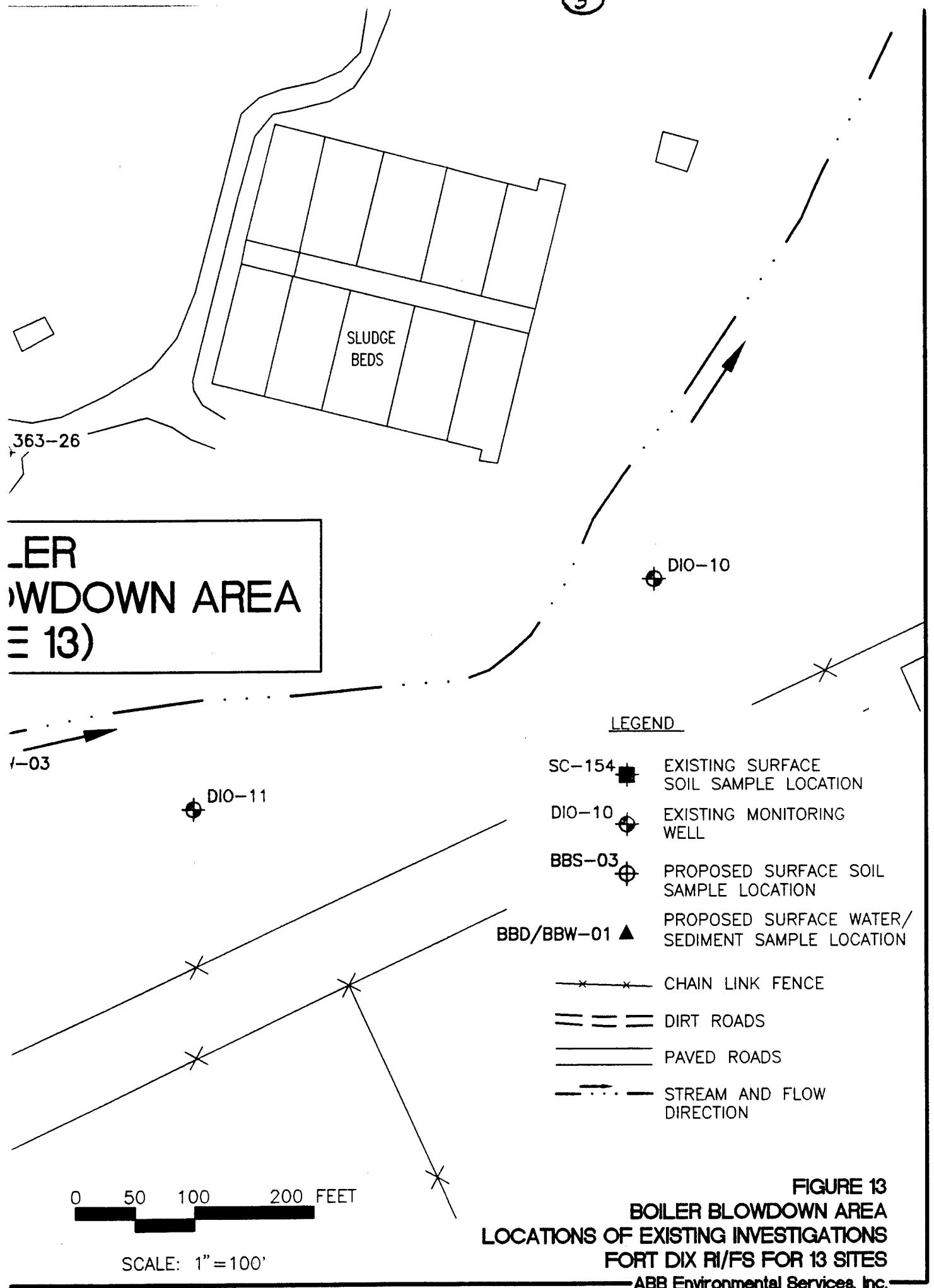
DIO-12

0 50 100 200 FEET

SCALE: 1"=100'

LC

(3)



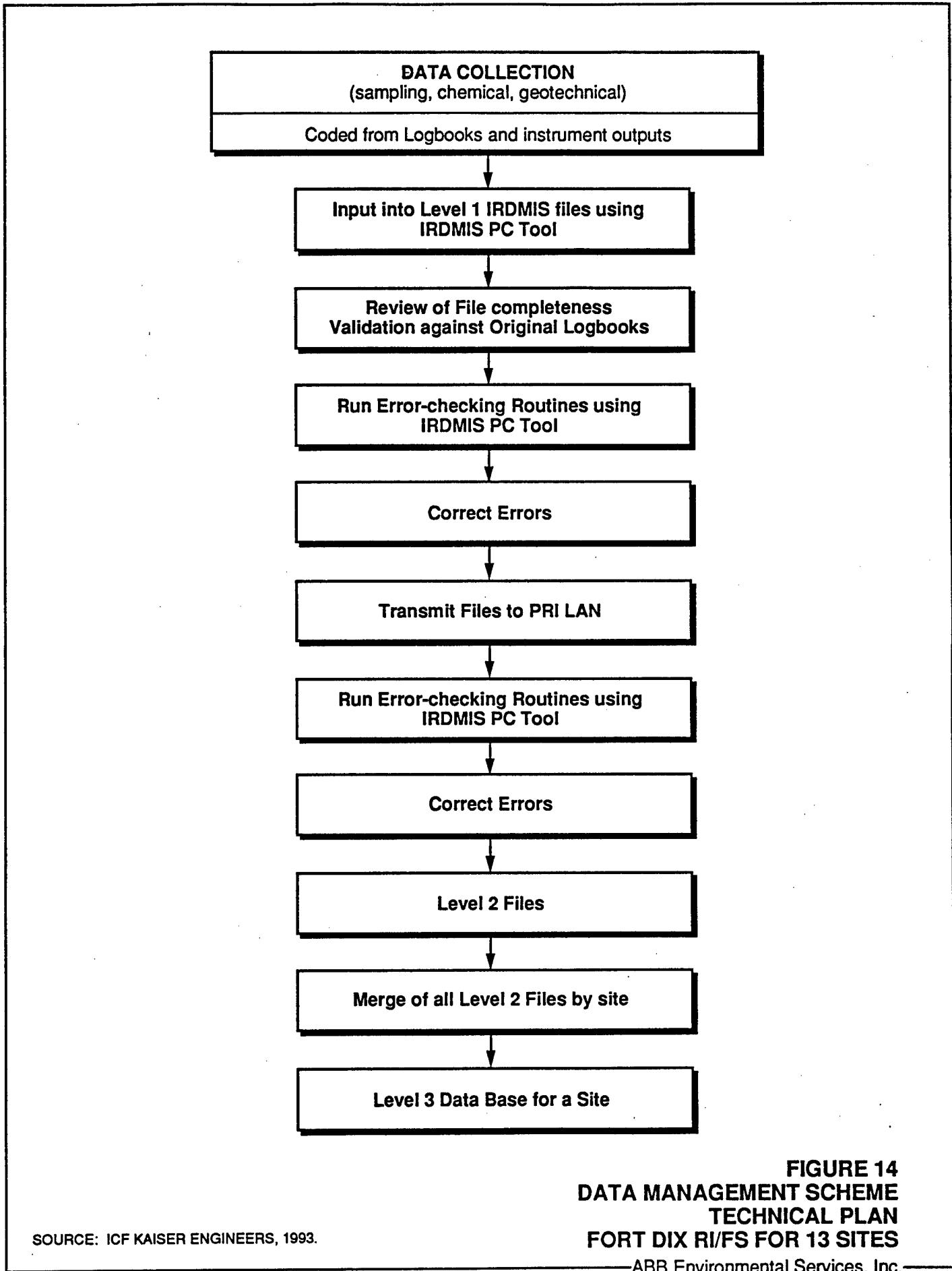


FIGURE 14
DATA MANAGEMENT SCHEME
TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

SOURCE: ICF KAISER ENGINEERS, 1993.

ABB Environmental Services, Inc.

TABLE 1
SUMMARY OF FIELD INVESTIGATION ACTIVITIES

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

SITE NUMBER	SITE NAME	INVESTIGATIVE APPROACH
2	POL Area	<ul style="list-style-type: none"> • Perform geophysical survey to approximate locations of former USTs. • Resurvey selected monitoring wells to better define locations. • Survey site area for 2 foot contours. • Drill 5 soil borings to evaluate residual soil. • Sample storm sewer discharge points. • Conduct field screening program for groundwater. • If needed, install, develop, and slug test additional monitoring wells • Sample existing and/or new monitoring wells.
3	Fire Tank Training Area	<ul style="list-style-type: none"> • Two phased approach. • Confirm locations and integrity of monitoring wells. • Collect surface water/sediment samples from Dogwood Brook. • Install 2 soil borings, one in the fire tank and one in bermed area, and analyze using field screening. • If contaminant concentrations exceed levels of concern then: • Install additional soil borings and perform field screening. • Install 2 piezometers and 2 staff gauges adjacent to Dogwood Brook. • Install, develop, sample, and slug test new monitoring wells. • Sample new and/or existing monitoring wells.
4	Golf Course Leaking Tank Area	<ul style="list-style-type: none"> • Survey site area for 2 foot contours. • Confirm locations and integrity of monitoring wells. • Conduct groundwater field screening program. • Install, develop, sample, and slug test monitoring wells. • Install stream gauges. • Collect core sample of sediments from pond bottoms. • Collect 9 surface water/sediment samples. • Conduct aquifer test. • Develop groundwater flow and contaminant transport models.
5	Transportation Motor Pool	<ul style="list-style-type: none"> • Confirm locations and integrity of monitoring wells. • Survey location of underground conduit from Dogwood Lake. • Establish approximate locations of previous boring E3, F3, G3, H3. • Install soil borings, and perform field screening. • Install, develop, sample, and slug test monitoring wells. • Test pit adjacent to conduit. • Evaluate surface water/sediment media based on Fire Tank Training Area samples.

TABLE 1
SUMMARY OF FIELD INVESTIGATION ACTIVITIES

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

SITE NUMBER	SITE NAME	INVESTIGATIVE APPROACH
6	ARDC Test Facility	<ul style="list-style-type: none"> • Sample FTDIX-13 to assess accuracy of previous sampling. • Confirm locations and integrity of monitoring wells. • Collect surface and subsurface soil samples. • Collect surface water/sediment samples. • Install, develop, sample, and slug test monitoring well. • Pump FTDIX-13 and monitor monitoring well water levels, if necessary. • Sample new and existing monitoring wells, including FTDIX-13.
8	Pesticide Control Shop	<ul style="list-style-type: none"> • Conduct monitoring well survey. • Perform phased field screening program for soils and groundwater. • Surface water/sediment sample program. • Pending results of field screening, install soil borings and or monitoring wells, collect and analyze samples. • Slug test new monitoring wells.
9	New Egypt Armory	<ul style="list-style-type: none"> • Produce base map with cultural and topographic features. • Sample and analyze contents of USTs. • Confirm location and integrity of monitoring wells. • Perform phased field screening program for soils and groundwater. • Collect and analyze surface water/sediment samples. • Install, develop, sample and slug test new monitoring wells, also sample existing monitoring wells.
10	Range Landfill	<ul style="list-style-type: none"> • Produce base map with cultural and topographic features. • Confirm location and integrity of monitoring wells. • Perform geophysical survey. • Perform gross radiation survey. • Define regional hydrogeologic conditions. • Perform field screening of groundwater. • Install, develop, sample, and slug test additional monitoring wells.
11	ANC-9 Landfill	<ul style="list-style-type: none"> • Review EI/AA Report by ICF for groundwater flow and chemical data. • Perform surface geophysical survey. • Excavate test pits in areas in observed trenches. • Sample soils from test pits.

TABLE 1
SUMMARY OF FIELD INVESTIGATION ACTIVITIES

**TECHNICAL PLAN
 FORT DIX RI/FS FOR 13 SITES**

SITE NUMBER	SITE NAME	INVESTIGATIVE APPROACH
12	ANC-2 Disposal Area	<ul style="list-style-type: none"> • Survey excavation boundary and produce topographic contours (2 foot interval). • Confirm location and integrity of monitoring wells. • Collect and analyze surface water/sediment samples. • Perform groundwater field screening program. • Install, develop, sample, and slug test monitoring wells. • Sample existing monitoring wells.
13	Boiler Blowdown Area	<ul style="list-style-type: none"> • Review ongoing efforts at 4400 Motor Pool for relevant data. • Collect and analyze surface soils of samples. • Collect and analyze surface water/sediment samples.
14	Area North of Dogwood Lake	<ul style="list-style-type: none"> • Confirm location and integrity of monitoring wells. • Determine groundwater flow direction utilizing existing wells. • Review EI/AA Report by ICF for additional surface water/sediment information. • Collect surface water and sediment samples. • Perform groundwater field screening program. • Install, develop, sample, and slug test monitoring wells.
15	Golf Course Pesticide Mixing and Storage Area	<ul style="list-style-type: none"> • Survey site area for 2 foot contours. • Conduct soil borings with field screening. • Collect sediment samples. • Collect surface soil samples.

PROPOSED HYDROGEOLOGICAL MONITORING

FC

SITE	MONITORING WELL PIEZOMETER SITE I.D.	TOP OF PVC/GROUND ELEVATION	DEPTH OF WELL FROM TOC PVC (feet)	SCREEN INTERVAL (bgs)	APPROXIMATE DEPTH TO WATER (from TOC)	WELL MATERIAL
Site 2 POL Area						
	EXISTING MONITORING WELLS					
	POL-5	156.16/153.84	37.2	25-35	16.2-17.2	4" PVC
	POL-6	156.48/154.54	27.0	15-25	16.7-17.5	
	POL-7	150.87/148.93	26.0	14-24	11.8-12.8	
	POL-8	152.78/150.93	26.9	15-25	13.5-14.5	
	POL-48	153.19/151.00	27.2	10-25	13.7-14.7	
	POL-49	156.29/153.70	30.0	12.5-27.5	16.5-17.3	
	POL-50	158.57/156.10	30.0	12.5-27.5	18.4-19.2	
	PROPOSED EXPLORATIONS					
	Field Screening		N/A	N/A	15 Feet	N/A
	PLA-01					
	PLA-02					
	PLA-03					
	PLA-04					
	PLA-05					
	<u>Monitoring Wells</u>					
	PLG-01 (Optional)		Shallow	Water Table	15 Feet	4" PVC
	PLG-02 (Optional)					
	PLG-03 (Optional)					
	PLG-04 (Optional)					
	PLG-05 (Optional)					
Site 3 Fire Training Tank Area						
	EXISTING MONITORING WELLS					
	FTT-13	127.27/125.57	26.7	15-25	2.9-3.3	4" PVC
	FTT-14	126.34/124.34	20.0	8-18	2.4-2.8	
	FTT-51	138.95/136.7	32.2	20-30	12.0-13.0	
	PROPOSED EXPLORATIONS					
	<u>Monitoring Wells</u>					
	FTG-01A (Optional)		Shallow	Water Table	10 Feet	4" PVC
	FTG-01B (Optional)		Deep	TFCU		
	FTG-02A (Optional)		Shallow	Water Table		
	FTG-02B (Optional)		Deep	TFCU		
	FTG-03A (Optional)		Shallow	Water Table		
	FTG-03B (Optional)		Deep	TFCU		
	<u>Piezometers</u>					
	FTPiez-1		Shallow	Water Table		2" PVC
	FTPiez-2		Shallow	Water Table		2" PVC

(1)

TABLE 2
PROPOSED HYDROGEOLOGIC INVESTIGATION ACTIVITIES

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

REACH INTERVAL (gs)	APPROXIMATE DEPTH TO WATER (from TOC)	WELL MATERIAL	DRILLING METHOD	EST. EXPLORATION DEPTH AND SAMPLE INTERVAL	FIELD SCREENING ANALYSES	ANALYTICAL LABORATORY ANALYSES
-35	16.2-17.2	4" PVC	Rotary	5' intervals	N/A	TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), and TSS.
-25	16.7-17.5					
-24	11.8-12.8					
-25	13.5-14.5					
-25	13.7-14.7					
-27.5	16.5-17.3					
-27.5	18.4-19.2			Continuous		
<hr/>						
/A	15 Feet	N/A	Geoprobe/ Screened Augers	Water samples at 5' intervals from water table surface to max. 35 ft. bgs	BTEX, TPH	10% confirmatory analyses for TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), TPH, and TSS.
Table	15 Feet	4" PVC	HSA	Soil samples at 5' intervals to approximately 25 ft. bgs	N/A	TCL VOCs, TCL SVOCs, TAL metals, and TSS (grain size analysis from screen interval).
25 18 30	2.9-3.3 2.4-2.8 12.0-13.0	4" PVC	Rotary	Soil samples at 5' intervals Soil samples at 5' intervals Soil samples continuous to 10', at 5' intervals below 10'	N/A	TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), explosives, and TSS.
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Table DU Table DU Table DU Table DU	10 Feet	4" PVC	HSA Rotary HSA Rotary HSA Rotary	Soil samples at 5' intervals. Shallow wells estimated to be 20 ft. deep, deep wells estimated to be 45 ft. deep.	N/A	TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), explosives, and TSS (grain size analysis from well screen interval).
Table Table		2" PVC 2" PVC	HSA HSA	N/A N/A	N/A N/A	N/A N/A

TION ACTIVITIES

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EXPLORATION DEPTH AND SAMPLE INTERVAL	FIELD SCREENING ANALYSES	ANALYTICAL LABORATORY ANALYSES	NOTES
5' intervals Continuous	N/A	TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), and TSS.	One round of samples collected from existing wells.
Samples at 5' intervals from surface to max. Samples at 5' intervals approximately 25 ft. bgs	BTEX, TPH N/A	10% confirmatory analyses for TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), TPH, and TSS. TCL VOCs, TCL SVOCs, TAL metals, and TSS (grain size analysis from screen interval).	Field screening will terminate upon two consecutive samples below detection limits. Estimated to be 35 ft. bgs. Wells installed only if existing wells are improperly located to characterize contaminant plumes. One round of samples will be collected.
Samples at 5' intervals Samples at 5' intervals Samples continuous to 10', wells below 10'	N/A	TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), explosives, and TSS.	One round of samples will be collected.
Samples at 5' intervals. Wells estimated to be deep wells to be 45 ft. deep. N/A N/A	N/A N/A	TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), explosives, and TSS (grain size analysis from well screen interval). N/A N/A	Shallow wells installed if tank area screening indicates contamination, deep wells installed if tank area screening detects TCA. One round of samples will be collected. Installed if tank area screening detects contamination. Determine hydraulic connection to surface water.

PROPOSED HYD

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SITE	MONITORING WELL PIEZOMETER SITE I.D.	TOP OF PVC/GROUND ELEVATION	DEPTH OF WELL FROM TOC PVC (feet)	SCREEN INTERVAL (bgs)	APPROXIMATE DEPTH TO WATER (from TOC)	WELL MATERIAL
Site 4 Golf Course Leaking Tank Area	EXISTING MONITORING WELLS					
	GLF-15	146.27/144.52	26.9	15-25	11.3-12.3	4" PVC
	GLF-16	142.04/140.25	24.1	12-22	8.8-9.6	
	GLF-17	136.67/NA	26.0	14-24	5.1-5.7	
	GLF-52	138.48/NA	25.0 (bgs)	15-25	0.9-1.4	
	GLF-53	139.32/139.75	25.0 (bgs)	15-25	2.4-2.9	
	GLF-73	138.96/139.22	20.0	10-20	3.1-3.6	
	GLF-74		20.0	10-20	2.8-3.4	
	PROPOSED EXPLORATIONS					
	<u>Field Screening</u>		N/A	N/A	5 Feet	N/A
	GTA-01					
	GTA-02					
	GTA-03					
	GTA-04					
	GTA-05					
	GTA-06					
	GTA-07					
	GTA-08					
	GTA-09					
	GTA-10					
	GTA-11					
	GTA-12					
	GTA-13					
	GTA-14					
	GTA-15					
	GTA-16					
	GTA-17					
	GTA-18					
	GTA-19					
	GTA-20					
	GTA-21					
	<u>Monitoring Wells</u>					
	GTG-01A		Shallow	Water Table	5 Feet	4" PVC
	GTG-01B		Deep	TFCU		
	GTG-02A		Shallow	Water Table		
	GTG-02B		Deep	TFCU		
	GTG-03A		Shallow	Water Table		
	GTG-03B		Deep	TFCU		
	GTG-04A		Shallow	Water Table		
	GTG-04B		Deep	TFCU		
	GTG-05		Shallow	Water Table		
	GTG-06					
	GTG-07					
	GTG-08					

(1)

TABLE 2
PROPOSED HYDROGEOLOGIC INVESTIGATION ACTIVITIES

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

SCREEN INTERVAL (bgs)	APPROXIMATE DEPTH TO WATER (from TOC)	WELL MATERIAL	DRILLING METHOD	EST. EXPLORATION DEPTH AND SAMPLE INTERVAL	FIELD SCREENING ANALYSES	ANALYTIC/ LABORATO/ ANALYSES
15–25	11.3–12.3	4" PVC	Mud Rotary	Soil samples at 5' intervals	N/A	TCL VOCs, TCL SVOCs, TAL inorganics (filtered and unfiltered), TSS, TDS, pesticides and herbicides, BOD5, COD, hardness and Alkalinity.
12–22	8.8–9.6					
14–24	5.1–5.7					
15–25	0.9–1.4					
15–25	2.4–2.9					
10–20	3.1–3.6					
10–20	2.8–3.4					
N/A	5 Feet	N/A	Geoprobe/ Screened Auger	Groundwater samples collected at 5' intervals from water table surface to approximately depth of 25 ft. bgs.	BTEX and pesticides (see analytical laboratory for lead.)	Samples will also be submitted for laboratory analyses of lead (filtered and unfiltered) and TSS confirmatory analyses VOCs, TCL SVOCs, TAL pesticides and herbicides.
Outer Table TFCU Outer Table TFCU Outer Table TFCU Outer Table TFCU Outer Table TFCU Outer Table	5 Feet	4" PVC	HSA Mud Rotary HSA Mud Rotary HSA Mud Rotary HSA Mud Rotary HSA	Soil samples at 5' intervals; shallow wells estimated to be 15 ft. deep. Deep wells estimated to be 30 ft.	N/A	TCL VOCs, TCL SVOCs, TAL inorganics, TSS, TDS, pesticides, herbicides, BOD5, COD, hardness and alkalinity (grain size analysis from well screen interval).
		4" PVC			N/A	

GATION ACTIVITIES

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ST. EXPLORATION DEPTH AND SAMPLE INTERVAL	FIELD SCREENING ANALYSES	ANALYTICAL LABORATORY ANALYSES	NOTES
Samples at 5' intervals	N/A	TCL VOCs, TCL SVOCs, TAL inorganics (filtered and unfiltered), TSS, TDS, pesticides and herbicides, BOD5, COD, hardness, and Alkalinity.	One round of samples will be collected from existing wells.
Samples continuous to 10', wells below 10', soil samples continuous to 12', wells below 12'			
Water samples collected at intervals from water surface to approximately 1 ft 25 ft. bgs.	BTEX and pesticides (see analytical laboratory for lead.)	Samples will also be submitted for laboratory analyses of lead (filtered and unfiltered) and TSS. 10% confirmatory analyses for TCL VOCs, TCL SVOCs, TPH, pesticides and herbicides.	Field screening will terminate at approximately 25' bgs.
Samples at 5' intervals; wells estimated to be deep. Deep wells estimated to be 30 ft.	N/A	TCL VOCs, TCL SVOCs, TAL inorganics, TSS, TDS, pesticides, herbicides, BOD5, COD, hardness, and alkalinity (grain size analysis from well screen interval).	Paired well nests, based on field screening results located on either side of pond to assess vertical gradients. Single wells based on field screening results to verify field screening. One round of samples will be collected from wells.
	N/A		(3)

PROPOSED HYDR

FOR

SITE	MONITORING WELL PIEZOMETER SITE I.D.	TOP OF PVC/GROUND ELEVATION	DEPTH OF WELL FROM TOC PVC (feet)	SCREEN INTERVAL (bgs)	APPROXIMATE DEPTH TO WATER (from TOC)	WELL MATERIAL
Site 5 Transportation Motor Pool	EXISTING WELLS					
	TMP-21	131.39/131.48	17.9	8-18	4.0-4.3	4" PVC
	TMP-22	134.23/132.36	26.9	15-25	7.6-8.0	
	TMP-54	137.22/135.20	27.0	15-25	8.7-9.5	
	TMP-55	143.81/141.50	29.8	17.5-27.5	12.3-12.7	
	TMP-56	144.68/142.50	29.7	17.5-27.5	11.9-13.2	
	PROPOSED EXPLORATIONS					
	<u>Field Screening</u>		N/A	N/A	10 Feet	N/A
	TMA-01					
	TMA-02					
	TMA-03					
	TMA-04					
	TMA-05					
	TMA-06					
	TMA-07					
	TMA-08					
	TMA-09					
	TMA-10					
	<u>Monitoring Wells</u>					
	TMG-01 (Optional)		Shallow	Water Table	10 Feet	4" PVC
	TMG-02 (Optional)					
	TMG-03 (Optional)					
Site 6 ARDC Test Facility	EXISTING MONITORING WELLS					
	FDIX-13					
	ARD-75	87.21/84.80	22.4	10-20	5.5-6.3	4" PVC
	ARD-76	86.61/84.20	22.4	10-20	4.6-5.0	
	ARD-77	84.25/83.60	20.7	10-20	4.3-4.7	
	PROPOSED EXPLORATIONS					
	<u>Field Screening</u>		N/A	N/A	5 Feet	N/A
	ARA-01					
	ARA-02					
	ARA-03					
	ARA-04					
	ARA-05					
	<u>Monitoring Wells</u>					
	ARG-01A (Optional)		Shallow	Water Table	5 Feet	4" PVC
	ARG-01B (Optional)		Deep	TFCU		

TABLE 2
PROPOSED HYDROGEOLOGIC INVESTIGATION ACTIVITIES

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

SCREEN INTERVAL (bgs)	APPROXIMATE DEPTH TO WATER (from TOC)	WELL MATERIAL	DRILLING METHOD	EST. EXPLORATION DEPTH AND SAMPLE INTERVAL	FIELD SCREENING ANALYSES	ANALYTIC LABORATORY ANALYS
8–18	4.0–4.3	4" PVC	Mud Rotary	Soil samples at 5' intervals.	N/A	TCL VOCs, TCL SVOCs, TAL metals (filtered & unfiltered), TPH, and
15–25	7.6–8.0					
15–25	8.7–9.5		Water Rotary	Soil samples continuous to 10 ft. bgs, 5' intervals to end.		
17.5–27.5	12.3–12.7					
17.5–27.5	11.9–13.2					
N/A	10 Feet	N/A	Geoprobe/ Screened Augers	Groundwater samples collected at 5' intervals starting at water table surface, and terminating at 25 ft. bgs.	Chlorinated Solvents, BTEX, and TPH	10% confirmatory analysis for TCL VOCs, TCL SVOCs, TAL metals (filtered & unfiltered), TPH, and
Water Table	10 Feet	4" PVC	HSA	Soil samples at 5' intervals; wells estimated to be approximately 20 ft. deep.	N/A	
10–20	5.5–6.3	4" PVC	N/A	Soil samples continuous to 12' ft. bgs, 5' intervals to end of boring.	N/A	TCL VOCs, TCL SVOCs, TAL metals (filtered & unfiltered), TSS, TPH, and pesticides.
10–20	4.6–5.0					
10–20	4.3–4.7					
N/A	5 Feet	N/A	Geoprobe/ Screened Augers	Groundwater samples collected at 5' intervals starting at water table and terminating at 25' ft. bgs.	BTEX, TPH	10% confirmatory analysis for TCL VOCs, TCL SVOCs, TAL metals (filtered & unfiltered), TSS,
Water Table TFCU	5 Feet	4" PVC	HSA Rotary	Soil samples at 5' intervals Shallow wells estimated to be 15 ft. deep. Deep wells estimated to be 45 ft. deep.	N/A	TCL VOCs, TCL SVOCs, TAL metals (filtered & unfiltered) TSS, and T (grain size analyses from well screen inter-

TION ACTIVITIES

ES

EXPLORATION DEPTH AND SAMPLE INTERVAL	FIELD SCREENING ANALYSES	ANALYTICAL LABORATORY ANALYSES	NOTES
oles at 5' intervals.	N/A	TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), TPH, and TSS.	One round of samples will be collected from existing wells.
oles continuous to 5' intervals to water table and terminating ats.			
ater samples at 5' intervals; rated to be entirely 20 ft. deep.	Chlorinated Solvents, BTEX, and TPH	10% confirmatory analyses for TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), TPH, and TSS.	Field screening will terminate at 25 ft. bgs.
oles at 5' intervals; rated to be entirely 20 ft. deep.	N/A	TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), TPH, and TSS (grain size analysis from well screen interval).	One round of samples will be collected.
oles continuous to 12' intervals to end of	N/A	TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), TSS, TPH, and pesticides.	See Technical Plan for sampling of Fort Dix-13. One round of samples will be collected from existing monitoring wells.
ater samples collected als starting at e and terminating gs.	BTEX, TPH	10% confirmatory analyses for TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), TSS, and TPH.	Field screening will terminate at 25' bgs.
oles at 5' intervals als estimated to be 15 Deep wells estimated deep.	N/A	TCL VOCs, TCL SVOCs, TAL metals, (filtered and unfiltered) TSS, and TPH (grain size analyses from well screen interval).	One round of samples will be collected.

PROPOSED HYDRO

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SITE	MONITORING WELL PIEZOMETER SITE I.D.	TOP OF PVC/GROUND ELEVATION	DEPTH OF WELL FROM TOC PVC (feet)	SCREEN INTERVAL (bgs)	APPROXIMATE DEPTH TO WATER (from TOC)	WELL MATERIAL	
Site 8 Pesticide Control Shop	EXISTING MONITORING WELLS	N/A	N/A	N/A	N/A	N/A	
	PROPOSED EXPLORATIONS						
	<u>Field Screening</u> PCA-01 PCA-02 PCA-03 PCA-04 PCA-05 PCA-06 PCA-07 PCA-08		N/A	N/A	15 Feet	N/A	Sc
	<u>Monitoring Wells</u> PCG-01 (Optional) PCG-02 (Optional) PCG-03 (Optional) PCG-04 (Optional)			Water Table	15 Feet	4" PVC	
Site 9 New Egypt Armory	EXISTING MONITORING WELLS						
	NEA 57	178.53/176.6	70	47.5-67.5	57.2-57.6	4" PVC	
	NEA 58	161.10/159.0	57	35-55	40.3-40.6		
	NEA 59	162.79/160.9	62	37.5-57.5	41.7-43.0		
	PROPOSED EXPLORATIONS						
	<u>Field Screening</u> NEA-01 (Optional) NEA-02 (Optional) NEA-03 (Optional) NEA-04 (Optional) NEA-05 (Optional)		N/A	N/A	40-60	N/A	Scr
	MONITORING WELLS						
	NEG-01 (Optional) NEG-02 (Optional) NEG-03 (Optional)		50-60	Water Table	40-50	4" PVC	

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TABLE 2
PROPOSED HYDROGEOLOGIC INVESTIGATION ACTIVITIES

**TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES**

REEN ERVAL bgs)	APPROXIMATE DEPTH TO WATER (from TOC)	WELL MATERIAL	DRILLING METHOD	EST. EXPLORATION DEPTH AND SAMPLE INTERVAL	FIELD SCREENING ANALYSES	ANALYTICAL LABORATORY ANALYSES
N/A	N/A	N/A	N/A	N/A	N/A	N/A
I/A	15 Feet	N/A	Geoprobe/ Screened Auger	Groundwater samples at 5' intervals, starting at water table and ending at 25' ft. bgs.	BTEX, herbicides, and pesticides.	10% confirmatory analyses for TCL VOCs, TCL SVOCs, TAL inorganics (filtered and unfiltered), TSS, pesticide herbicides, and explosive
Table	15 Feet	4" PVC	HSA	Soil samples at 5' intervals. Wells estimated to be 25 ft. deep.	N/A	TCL VOCs, TCL SVOCs, TAL inorganics (filtered and unfiltered), TSS, pesticide herbicides, and explosive (grain size analyses from screen interval).
-67.5 -55 -57.5	57.2-57.6 40.3-40.6 41.7-43.0	4" PVC	Rotary	Soil samples at five-foot intervals.	N/A	TCL VOCs, TCL SVOCs, Metals (filtered and unfilte TSS, and TPH.
I/A	40-60	N/A	Geoprobe/ Screened Augers	Groundwater samples at five-foot intervals starting at the water table and extending 30 feet below the water table.	Chlorinated Solvent, BTEX, and TPH.	10% confirmatory analyse TCL VOCs, TCL SVOCs, Metals (filtered and unfilte TPH, and TSS.
Table	40-50	4" PVC	Rotary/HSA	Soil samples at five-foot intervals. Wells established to be 50-60 feet bgs.	N/A	TCL VOCs, TCL SVOCs, Metals (filtered and unfilte TPH, and TSS.

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ES

EXPLORATION DEPTH AND SAMPLE INTERVAL	FIELD SCREENING ANALYSES	ANALYTICAL LABORATORY ANALYSES	NOTES
N/A	N/A	N/A	No existing monitoring wells present.
water samples at intervals, starting at 10' and ending at 30'. holes at 5' intervals. estimated to be 25	BTEX, herbicides, and pesticides.	10% confirmatory analyses for TCL VOCs, TCL SVOCs, TAL inorganics (filtered and unfiltered), TSS, pesticides, herbicides, and explosives.	Field screening will terminate at 25 ft. bgs.
	N/A	TCL VOCs, TCL SVOCs, TAL inorganics (filtered and unfiltered), TSS, pesticides, herbicides, and explosives (grain size analyses from well screen interval).	Installed only if field screening indicates groundwater contamination. One round of samples will be collected.
oles at intervals.	N/A	TCL VOCs, TCL SVOCs, TAL Metals (filtered and unfiltered), TSS, and TPH.	One round of samples will be collected from existing wells.
water samples at intervals starting at the water table and extending 30 feet above water table.	Chlorinated Solvent, BTEX, and TPH.	10% confirmatory analyses for TCL VOCs, TCL SVOCs, TAL Metals (filtered and unfiltered), TPH, and TSS.	Field screening performed if soil borings suggest groundwater contamination. Field screening to terminate at 30 feet into water table.
oles at five-foot intervals established to be at bgs.	N/A	TCL VOCs, TCL SVOCs, TAL Metals (filtered and unfiltered), TPH, and TSS.	Monitoring wells installed if data from screened augers detect groundwater contamination and if existing wells are not positioned properly.

PROPOSED HYDRC

FOR

SITE	MONITORING WELL PIEZOMETER SITE I.D.	TOP OF PVC/GROUND ELEVATION	DEPTH OF WELL FROM TOC PVC (feet)	SCREEN INTERVAL (bgs)	APPROXIMATE DEPTH TO WATER (from TOC)	WELL MATERIAL
Site 10 Range Landfill	EXISTING MONITORING WELLS					
	RLF-27	171.56/169.95	49.6	28-48	43.5-44.8	4" PVC
	RLF-28	174.65/172.56	70.1	48-68	45.90	
	RLF-29	178.46/176.52	68.0	48-68	40.9-41.3	
	RLF-30	180.55-178.68	74.8	53-73	49.8-50.0	
	PROPOSED EXPLORATIONS					
	<u>Field Screening</u>		N/A	N/A	45 Feet	N/A
	RLA-01					Sc
	RLA-02					
	RLA-03					
	RLA-04					
	RLA-05					
	RLA-06					
	RLA-07					
	<u>Monitoring Wells</u>					
	RLG-01		Shallow	Water Table	45 Feet	4" PVC
	RLG-02					
	RLG-03					
	RLG-04					
	RLG-05					
Site 11 ANC-9 Landfill	EXISTING MONITORING WELLS					
	AN9-38	161.48/159.48	50.0	28-48	40.33	4" PVC
	AN9-39	160.36/158.47	57.0	35-55	38.67	
	WES-3	N/A	46.0	N/A	43.90	
	PROPOSED EXPLORATIONS					
	N/A	N/A	N/A	N/A	N/A	N/A
Site 12 ANC-2 Disposal Area	EXISTING MONITORING WELLS					
	AN2-40	143.10/141.50	41.6	20-40	23.4	4" PVC
	AN2-41	145.85/144.11	41.7		24.3	
	AN2-42	146.69/143.69	41.2		23.5	
	PROPOSED EXPLORATIONS					
	<u>Field Screening</u>		N/A	N/A	25 Feet	N/A
	A2A-01					Sc
	A2A-02					
	A2A-03					
	A2A-04					
	A2A-05					
	A2A-06					

(1)

TABLE 2
PROPOSED HYDROGEOLOGIC INVESTIGATION ACTIVITIES

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

GREEN INTERVAL (sgs)	APPROXIMATE DEPTH TO WATER (from TOC)	WELL MATERIAL	DRILLING METHOD	EST. EXPLORATION DEPTH AND SAMPLE INTERVAL	FIELD SCREENING ANALYSES	ANALYTICAL LABORATORY ANALYSES
3-48	43.5-44.8	4" PVC	Rotary	Soil samples at 5' intervals.	N/A	TCL VOCs, TCL SVOCs, explosives, TAL metals (f and unfiltered), TSS, gross alpha, beta, gamma.
3-68	45.90					
3-68	40.9-41.3					
3-73	49.8-50.0					
I/A	45 Feet	N/A	Screened Augers	Groundwater samples at 10' intervals, starting at the water table and ending 30' ft. below water table.	BTEX, radiation, and explosives (see analytical laboratory for metals.)	Sample will also be submitted for laboratory analyses of metals (nonfiltered and filtered) and TSS. 10% confirmatory analyses for VOCs, TCL SVOCs, gross alpha, beta, and gamma, explosives.
Table	45 Feet	4" PVC	HSA	Soil samples at 5' intervals. Wells estimated to be 55 ft. deep.	N/A	TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), TSS, gross alpha, beta, and gamma, and explosives.
-48	40.33	4" PVC	Rotary	Soil samples at 5' intervals.	N/A	TCL VOCs, TCL SVOCs,
-55	38.67					Metals (filtered and unfiltered), TSS, and explosives.
I/A	43.90		N/A	N/A		
I/A	N/A	N/A	N/A	N/A	N/A	
-40	23.4	4" PVC	Rotary	Soil samples at 5' intervals.		TCL VOCs, TCL SVOCs, TAL metals, TSS, BOD5, COD, TDS, alkalinity, hardness, gross alpha, beta and gamma.
I/A	24.3					
I/A	23.5					
I/A	25 Feet	N/A	Screened Auger/ Geoprobe	Groundwater samples at 10' intervals, to 30' ft. below water table.	Radiation (see analytical laboratory for nickel.)	Samples will also be submitted for laboratory analyses of (nonfiltered and filtered) a 10 %confirmatory analyses for VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), TSS, BOD5, COD,TDS, hardness, alkalinity, gross alpha, beta, and gamma.

I ACTIVITIES

LOCATION TH AND SAMPLE INTERVAL	FIELD SCREENING ANALYSES	ANALYTICAL LABORATORY ANALYSES	NOTES
5' intervals.	N/A	TCL VOCs, TCL SVOCs, explosives, TAL metals (filtered and unfiltered), TSS, gross alpha, beta, gamma.	One round of samples will be collected from existing wells.
Samples starting at and ending at water table.	BTEX, radiation, and explosives (see analytical laboratory for metals.)	Sample will also be submitted for laboratory analyses of TAL metals (nonfiltered and filtered) and TSS. 10% confirmatory analyses for TCL VOCs, TCL SVOCs, gross alpha, beta, and gamma, and explosives.	Field screening to terminate approximately 30 feet into water table.
5' intervals. 1 to be 55 ft.	N/A	TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), TSS, gross alpha, beta, and gamma, and explosives.	Installed if metals data from screened augers indicates contamination. Depths will be contingent on metals data.
5' intervals. I/A	N/A	TCL VOCs, TCL SVOCs, TAL Metals (filtered and unfiltered), TSS, and explosives.	One round of groundwater sampling from existing wells.
I/A	N/A		No groundwater explorations proposed.
5' intervals.		TCL VOCs, TCL SVOCs, TAL metals, TSS, BOD5, COD, TDS, alkalinity, hardness, gross alpha, beta and gamma.	One round of samples will be collected from existing wells.
Samples at 30' ft. below	Radiation (see analytical laboratory for nickel.)	Samples will also be submitted for laboratory analyses of nickel (nonfiltered and filtered) and TSS. 10 %confirmatory analyses for TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), TSS, BOD5, COD,TDS, hardness, alkalinity, gross alpha, beta and gamma.	Field screening to terminate 30 feet into the water table.

PROPOSED HYD

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SITE	MONITORING WELL PIEZOMETER SITE I.D.	TOP OF PVC/GROUND ELEVATION	DEPTH OF WELL FROM TOC PVC (feet)	SCREEN INTERVAL (bgs)	APPROXIMATE DEPTH TO WATER (from TOC)	WELL MATERIAL
Site 12 (cont.)	Monitoring Wells A2G-01 (Optional) A2G-02 (Optional) A2G-03 (Optional) A2G-04 (Optional)		Shallow	Shallow	25 Feet	4" PVC
Site 13 Boiler Blowdown Area	N/A	N/A	N/A	N/A	N/A	N/A
Site 14 Area North of Dogwood Lake	EXISTING MONITORING WELLS PTS-22 NDL-60 NDL-61 NDL-62 NDL-63 NDL-78 NDL-79	N/A 156.14/154.00 157.73/155.70 149.25/147.20 151.79/149.90 144.38/141.80 141.79/139.10	39.0 27.0 29.5 27.0 27.0 19.6 19.7	28.3-38.5 10-25 12.5-27.5 10-25 10-25 7-17 7-17	13.5 19.2-20.6 20.9-30.0 13.4-14.4 15.6-16.3 7.9-9.6 7.4-8.3	4" PVC
	PROPOSED EXPLORATIONS Field Screening DLA-01 DLA-02 DLA-03 DLA-04 DLA-05 DLA-06 DLA-07 DLA-08 DLA-09 DLA-10 DLA-11 DLA-12 DLA-13 DLA-14 DLA-15 DLA-16 DLA-17 DLA-18		N/A	N/A	5 to 15 Feet	N/A

TABLE 2
PROPOSED HYDROGEOLOGIC INVESTIGATION ACTIVITIES

**TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES**

OF ROM VC)	SCREEN INTERVAL (bgs)	APPROXIMATE DEPTH TO WATER (from TOC)	WELL MATERIAL	DRILLING METHOD	EST. EXPLORATION DEPTH AND SAMPLE INTERVAL	FIELD SCREENING ANALYSES	A LA /
W	Shallow	25 Feet	4" PVC	HSA	Soil samples at 5' intervals to approximately 35 ft. bgs.	N/A	TCL VOCs, TAL metals (unfiltered), COD, TDS, gross alpha (grain size screen inte
	N/A	N/A	N/A	N/A	N/A	N/A	
	28.3–38.5 10–25 12.5–27.5 10–25 10–25 7–17 7–17	13.5 19.2–20.6 20.9–30.0 13.4–14.4 15.6–16.3 7.9–9.6 7.4–8.3	4" PVC	Rotary	Soil samples continuous to 10' ft. bgs and 5' intervals to end of boring.	N/A	TCL VOCs, TAL metals (unfiltered),
	N/A	5 to 15 Feet	N/A	Geoprobe	Groundwater samples collected at 5' intervals starting at water table (estimated three samples per boring). Maximum depth will be 25' ft. bgs.	BTEX, TPH	10% confirm for TCL VOCs, TPH, TAL metals (unfiltered), a

INVESTIGATION ACTIVITIES

N
3 SITES

EST. EXPLORATION DEPTH AND SAMPLE INTERVAL	FIELD SCREENING ANALYSES	ANALYTICAL LABORATORY ANALYSES	NOTES
11 samples at 5' intervals approximately 35 ft. bgs.	N/A	TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), TSS, BOD5, COD, TDS, hardness, Alkalinity, gross alpha, beta and gamma (grain size analyses from well screen interval).	Wells will be installed if metals data from screened auger indicates contamination. Depths will be contingent on metals data.
	N/A	N/A	No groundwater exploration proposed at this site.
1 samples continuous to 10' bgs and 5' intervals to top of boring.	N/A	TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), TPH, and TSS.	One round of samples will be collected from existing wells.
Groundwater samples collected at 5' intervals starting at water table (estimated three samples per boring). Maximum depth will be 25 ft. bgs.	BTEX, TPH	10% confirmatory analyses for TCL VOCs, TCL SVOCs, TPH, TAL metals (filtered and unfiltered), and TSS.	Field screening will terminate at 25 ft. bgs.

PROPOSED HYDRC

FOR

SITE	MONITORING WELL PIEZOMETER SITE I.D.	TOP OF PVC/GROUND ELEVATION	DEPTH OF WELL FROM TOC PVC (feet)	SCREEN INTERVAL (bgs)	APPROXIMATE DEPTH TO WATER (from TOC)	WELL MATERIAL
Site 14 (cont.)	<u>Monitoring Wells</u> DLG-01 (Optional) DLG-02 (Optional) DLG-03 (Optional) DLG-04 (Optional)		Shallow	Water Table		4" PVC
Site 15 Golf Course	EXISTING MONITORING WELLS See Site 4 See Site 4					
	PROPOSED EXPLORATIONS	N/A		N/A	N/A	N/A

NOTES:

Elevations from EA 1989 and Dames and Moore 1993.

Laboratory analyses for metals will be for total and dissolved.

TCL VOCs = USEPA Target Compound List of Volatile Organic Compounds

TCL SVOCs = USEPA Target Compound List of Semivolatile Organic Compounds

TAL inorganics = USEPA Target Analyte List of metals and cyanide

TAL metals = USEPA Target Analyte List of metals

PVC = Polyvinyl Chloride

BOD5 = Biological Oxygen Demand

TSS = Total Suspended Solids

N/A = Not Applicable

bgs = below ground surface

TPH = Total Petroleum Hydrocarbons

TFCU = Top of First Confining Unit

TOC = Total Organic Carbon as a labora

TABLE 2
PROPOSED HYDROGEOLOGIC INVESTIGATION ACTIVITIES

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

N AL	APPROXIMATE DEPTH TO WATER (from TOC)	WELL MATERIAL	DRILLING METHOD	EST. EXPLORATION DEPTH AND SAMPLE INTERVAL	FIELD SCREENING ANALYSES	ANALYTICAL LABORATORY ANALYSES
ole		4" PVC	HSA	Soil samples at 5' intervals to approximately 25 ft. bgs.	N/A	TCL VOCs, TCL SVOCs, TPH, TAL metals, and TSS.
4	See Site 4	See Site 4	See Site 4	See Site 4	See Site 4	See Site 4
	N/A	N/A	N/A	N/A	N/A	N/A

TSS = Total Suspended Solids

N/A = Not Applicable

bgs = below ground surface

TPH = Total Petroleum Hydrocarbons

TFCU = Top of First Confining Unit

TOC = Total Organic Carbon as a laboratory analysis and top of casing as a well survey

ACTIVITIES

LOCATION TH AND MPLE ERVAL	FIELD SCREENING ANALYSES	ANALYTICAL LABORATORY ANALYSES	NOTES
at 5' intervals to 25 ft. bgs.	N/A	TCL VOCs, TCL SVOCs, TPH, TAL metals, and TSS.	Monitoring wells will be installed if field screening results detect contamination and existing wells are not properly positioned based on field screening results.
Site 4	See Site 4	See Site 4	See Site 4
N/A	N/A	N/A	Groundwater explorations are proposed under Site 4.

s a well survey

TABLE 3
SOIL SAMPLING PROGRAM
TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

SITE	SITE IDS	NUMBER OF ANALYTICAL SAMPLES	SAMPLE DEPTHS ANALYSIS	LOCATION	RATIONALE	DRILLING/ SAMPLING METHOD
Site 2 POL Area	Borings PLB-01	5 1 per boring	<ul style="list-style-type: none"> Continuous samples to water table field screened for BTEX and TPH. At least 10% confirmatory samples analyzed for TCL VOCs, TCL SVOCs, TAL metals, TOC, and TPH. 	Borings will be located near previously removed USTs.	To document any residual soil contamination from USTs.	HSA/Split-spoon
	PLB-02					
	PLB-03					
	PLB-04					
	PLB-05					
Site 3 Fire Training Tank Area	Phase I Borings FTB-01	6 3 per boring	<ul style="list-style-type: none"> Continuous samples to TFCU field screened for BTEX and chlorinated solvents. At least 10% confirmatory samples analyzed for TCL VOCs, TCL SVOCs, TAL metals, TOC, and explosives. 	One boring will be installed in the Fire Training Tank Location and one in the bermed pit. Anticipated depth of each boring is 45 feet.	To determine the presence or absence of contaminants at levels of concern in soils. If none are present then no further action is necessary; if present, continue investigation.	HSA/Split-spoon
	FTB-02	3 per boring Field Screening (23 per boring)				
Site 4 Golf Course Leaking Tank Area	6 Lab Analytical (3 per boring)					
	Phase II Borings (if necessary)	24 3 per boring	<ul style="list-style-type: none"> Continuous samples to TFCU field screened for BTEX and chlorinated solvents. Select at least 10% field screening samples for laboratory confirmation for TCL VOCs, TCL SVOCs, TAL metals, TOC, and explosives. 	Borings will be located down gradient from the fire tanks toward Dogwood Brook. Location selection will utilize screening data from Phase 1 borings.	To determine the distribution of contaminants.	HSA/Split-spoon
	FTB-03	184 Field Screening (23 per Boring)				
	FTB-04					
	FTB-05					
	FTB-06					
	FTB-07					
	FTB-08					
	FTB-09					
	FTB-10					
	N/A	N/A	N/A	N/A	N/A	N/A

TABLE 3
SOIL SAMPLING PROGRAM
TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

SITE	SITE IDs	NUMBER OF LABORATORY ANALYTICAL SAMPLES	SAMPLE DEPTHS ANALYSIS	LOCATION	RATIONALE	DRILLING/ SAMPLING METHOD
Site 5 Transportation Motor Pool Area	Borings TMB-01 TMB-02 TMB-03 TMB-04 TMB-05 TMB-06 TMB-07 TMB-08 TMB-09 TMB-10	20 2 per boring	<ul style="list-style-type: none"> Continuous samples to 25 ft. bgs field screened for BTEX, TPH. Select at least 10% field screening samples for laboratory confirmation for TCL VOCs, TCL SVOCs, TAL metals, TPH, and TOC. 	Borings will be located in vicinity of previous borings E3, F3, G3, and H3 drilled in 1985 (lKW, 1985).	To determine the presence or absence of contaminants at levels of concern in soils in area of previous tank removal action.	HSA/split-spoon
	Test Pits TMS-01 TMS-02 TMS-03	3 1 per test pit	<ul style="list-style-type: none"> 2 samples from each test pit field screened for BTEX, TPH. 1 sample from each test pit submitted for laboratory confirmation for TCL VOCs, TCL SVOCs, TAL metals, TPH, and TOC. 	Test pits located along buried culvert.	To determine presence or absence of contaminants at levels of concern in soils. Contaminants may be moving preferentially along outside of buried culvert.	Backhoe/ Grab
	Surface Soil ARS-01 ARS-02 ARS-03 ARS-04 ARS-05 ARS-06 ARS-07 ARS-08 ARS-09 ARS-10	10 1 per surface soil sample site	<ul style="list-style-type: none"> Surface soil samples will be analyzed for TCL VOCs, TCL SVOCs, TAL metals, TPH, and TOC. 	Boring and surface soil samples will be collected at fuel storage area.	To determine the presence or absence of contaminants at levels of concern in soils. If present, to help determine distribution of contamination.	Grab

TABLE 3
SOIL SAMPLING PROGRAM
TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

SITE	SITE IDs	NUMBER OF LABORATORY ANALYTICAL SAMPLES	SAMPLE DEPTHS ANALYSIS	LOCATION	RATIONALE	DRILLING/ SAMPLING METHOD
Site 6 ARDC Test Facility (continued)	Soil Borings ARB-01 ARB-02 ARB-03 ARB-04	1 ² 3 per boring	<ul style="list-style-type: none"> Collect samples from borings continuously to the water table. Up to 3 samples per boring will be submitted for laboratory analyses. Boring soil samples will be analyzed for TCL VOCs, TCL SVOCs, TAL Metals, TPbH, and TOC. 			HSA/split-spoon
Site 8 Pesticide Control Shop	Phase I Borings PCB-01 PCB-02	4 2 per boring	<ul style="list-style-type: none"> Continuous sampling to 25 ft. bgs, field screened for BTEX, pesticides, and herbicides. Select at least 10% field screening samples for laboratory confirmation for TCL VOCs, TCL SVOCs, TAL inorganics, herbicides, pesticides, and explosives. 	One boring in each of two gravel areas adjacent to north side of building.	To determine the presence or absence of contamination at levels of concern in soils and groundwater.	HSA/split-spoon
	Phase II Borings PCB-03 PCB-04 PCB-05 PCB-06 PCB-07 PCB-08	1 ² 2 per boring	<ul style="list-style-type: none"> Continuous sampling to 25 ft. bgs, field screened for BTEX, pesticides, and herbicides. Select at least 10% field screening samples for laboratory confirmation for TCL VOCs, TCL SVOCs, TAL inorganics, herbicides, pesticides, and explosives. 	Adjacent to the gravel areas.	If contamination detected in gravel area, drill borings to define distribution of soil contamination.	HSA/split-spoon

TABLE 3
SOIL SAMPLING PROGRAM
TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

SITE	SITE IDs	NUMBER OF LABORATORY ANALYTICAL SAMPLES	SAMPLE DEPTHS ANALYSIS	LOCATION	RATIONALE	DRILLING/ SAMPLING METHOD
Site 9 New Egypt Armory	Soil Borings NEB-01 NEB-02 NEB-03 NEB-04 NEB-05 NEB-06 NEB-07 NEB-08 NEB-09	14 1 to 2 per boring	<ul style="list-style-type: none"> NEB-01 through NEB-05 collect samples continuous to 15 feet bgs or bottom of contamination than at 5-foot intervals to the water table. NEB-06 through NEB-09 collect samples continuous to 10 feet bgs or bottom of contamination. Field screening for BTEX, chlorinated solvents, and TPH. Select at least 10% field screening samples for laboratory confirmation for TCL VOCs, TCL SVOCs, TAL Inorganics, TOC, and TPH. 	NEB-01 through NEB-05 located near USTs. NEB-06 through NEB-09 and surface soil samples located in vehicle parking area.	To determine presence or absence of contamination at levels of concern in soils. If present, to help determine distribution of chemicals.	HSA/split-spoon
Site 9 New Egypt Armory (continued)	Surface Soils NES-01 NES-02 NES-03 NES-04 NES-05 NES-06 NES-07 NES-08 NES-09 NES-10	10 1 per surface soil sample site	<ul style="list-style-type: none"> Boring and surface soil samples submitted for TCL VOCs, TCL SVOCs, and TAL inorganics. 			N/A
Site 10 Range Landfill	N/A	N/A	N/A			N/A
Site 11 ANC-9 Landfill	Test Pits A9S-01 A9S-02 A9S-03 A9S-04 A9S-05	5 1 per test pit	Grab soil samples from test pits analyze for TCL VOCs, TCL SVOCs, TAL metals, explosives, and TOC.	In areas of trenches observed in review of historical aerial photographs and during field visits.	To investigate nature of material observed in trenches.	Test Pit/ Grab

TABLE 3
SOIL SAMPLING PROGRAM
TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

SITE	SITE IDs	NUMBER OF LABORATORY ANALYTICAL SAMPLES	SAMPLE DEPTHS ANALYSIS	LOCATION	RATIONALE	DRILLING/ SAMPLING METHOD
Site 12 ANC-2 Disposal Area	N/A	N/A	N/A	N/A	N/A	N/A
Site 13 Boiler Blowdown Area	Surface Soils BBS-01 BBS-02 BBS-03 BBS-04 BBS-05 BBS-06 BBS-07 BBS-08 BBS-09 BBS-10 BBS-11	11 1 per surface soil sample site	<ul style="list-style-type: none"> Samples collected from 0 to 0.5 feet bgs along stream bank. Samples analyzed for TCL VOCs, TCL SVOCs, and TAL inorganics. 	Located near previous surface soil samples where thallium was detected.	To determine the presence or absence of contamination at levels of concern in surface soils. If present, to help determine distribution of chemicals.	Grab
Site 14 Area North of Dogwood Lake	Well Boring DLG-01(optional) DLG-02(optional) DLG-03(optional) DLG-04(optional)	8 2 per boring	<ul style="list-style-type: none"> Continuous soil samples from 10 feet above water table to 5 feet below water table, field screen samples for BTEX and TPH. Select at least 10 percent field screening samples for laboratory confirmation for TCL VOCs, TCL SVOCs, TAL Metals, and TPH. 	Wells to be located north of Dogwood Lake in area of groundwater contamination, if detected in geoprobe program.	To enhance evaluation of potential free product.	HSA/split-spoon
Site 15 Golf Course Pesticide Mixing and Storage Area	Soil Borings GPB-01 GPB-02	4 2 per boring	<ul style="list-style-type: none"> Continuous samples to water table, field screened samples for BTEX, pesticides, and herbicides. Select at least 10% field screening samples for laboratory confirmation for TCL VOCs, TCL SVOCs, TAL inorganics, pesticides, herbicides, and TOC. 	Borings located within mapped boundary of mixing area. Analytical confirmatory samples collected from ground surface, water table, and top of first major fine grained soil unit.	To determine the presence or absence of contaminants at levels of concern in soils. If present, to help determine distribution of contamination.	HSA/split-spoon

TABLE 3
SOIL SAMPLING PROGRAM
TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

SITE	SITE IDs	NUMBER OF LABORATORY ANALYTICAL SAMPLES	SAMPLE DEPTHS ANALYSIS	LOCATION	RATIONALE	DRILLING/ SAMPLING METHOD
Site 15 Golf Course Pes- ticide Mixing and Storage Area (continued)	Surface Soil GPS-01 GPS-02 GPS-03 GPS-04 GPS-05 GPS-06 GPS-07 GPS-08 GPS-09 GPS-10 GPS-11 GPS-12	12 1 per surface soil sample site	Analyze three samples for TCL VOCs, TCL SVOCs, pesticides, herbicides, TAL inorganics, and TOC.	Collect samples in grid pattern in unpaved areas of the Pesticide Mixing Area.	To determine the presence or absence of contaminants at levels of concern in soils. If present, to help determine distribution of contamination.	Grab

Notes:

BTEX = Benzene, toluene, ethylbenzene, and xyrene
 1,1,1-TCE = 1,1,1-Trichloroethane
 TCL VOCs = USEPA Target Compound List of Volatile Organic Compounds
 TCL SVOCs = USEPA Target Compound List of Semivolatile Organic Compounds
 TAL Metals = USEPA Target Analyte List of Metals
 TAL Inorganics = USEPA Target Analyte List Metals and Cyanide
 TOC = Total Organic Carbon
 TPH = Total Petroleum Hydrocarbons

TABLE 4
SURFACE WATER/SEDIMENT ASSESSMENT PROGRAM
TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

SITE	SITE ID	MEDIA	CHEMICAL ANALYSES	LOCATION	RATIONALE
Site 2 POL Area	PLD/PLW-01	Storm Sewer Water and Sediment	TCL VOCs, TCL SVOCs, TAL Metals, PCBs, TOC (sediment), Alkalinity/hardness (surface water), Grain Size Analyses	Sample discharge points of storm sewers and downgradient drainage	Water flow may be potentially derived from shallow groundwater and may be a transport mechanism.
	PLD/PLW-02				
	PLD/PLW-03				
	PLD/PLW-04				
	PLD/PLW-05				
Site 3 Fire Training Tank Area	FTD/FTW-01	Surface Water Sediment	TCL VOCs, TCL SVOCs, TAL Metals, PCBs, Explosives, TOC (sediment), Alkalinity/hardness (surface water), Grain Size Analyses	5 locations along Dogwood Brook: 2 upstream, 2 at site, 1 downstream.	Stream flow is potentially derived from shallow groundwater. All five locations will be used for Fire Training Tank Area (Site 3) and Transportation Motor Pool Area (Site 5).
	FTD/FTW-02				
	FTD/FTW-03				
	FTD/FTW-04				
	FTD/FTW-05				
Site 4 Golf Course Leaking Tank Area	GTD/GTW-01	Surface Water Sediment	TCL VOCs, TCL SVOCs, TAL Inorganics, PCBs, Pesticides, Herbicides, TOC (sediment), Alkalinity/hardness (surface water), Grain Size Analyses	Ponds and stream.	Ponded water is potentially in connection with shallow groundwater flow. Pesticide/herbicide analysis is associated with Site 15 Golf Course Pesticide Mixing and Storage Area.
	GTD/GTW-02				
	GTD/GTW-03				
	GTD/GTW-04				
	GTD/GTW-05				
Site 5 Transportation Motor Pool	GTD/GTW-06				
	GTD/GTW-07				
	GTD/GTW-08				
	GTD/GTW-09				
	See Site 3 above	See Site 3 above	See Site 3 above	See Site 3 above	See rationale for Site 3 Fire Training Tank Area.
Site 6 ARDC Test Facility	ARD/ARW-01	Surface Water Sediment	TCL VOCs, TCL SVOCs, TAL Metals, PCBs, Pesticides, TOC (sediment), Alkalinity/hardness (surface water), Grain Size Analyses	At three locations along drainage ditch south of ARDC.	To assess impacts from ARDC on drainage ditch and confirm previous sampling. ARD/ARW-04 through ARD/ARW-08 are optional and dependent on detecting contamination in field screening (BTEX, TCE and TPH) on ARD/ARW-01 through ARD/ARW-03.
	ARD/ARW-02				
	ARD/ARW-03				
	ARD/ARW-04				
	ARD/ARW-05				
	ARD/ARW-06				
	ARD/ARW-07				
	ARD/ARW-08				

TABLE 4
SURFACE WATER/SEDIMENT ASSESSMENT PROGRAM
TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

SITE	SITE ID	MEDIA	CHEMICAL ANALYSES	LOCATION	RATIONALE
Site 8 Pesticide Control Shop	PCD/PCW-01 PCD/PCW-02 PCD/PCW-03	Surface Water Sediment	TCL VOCs, TCL SVOCs, TAL Inorganics, PCBs, Herbicides, Pesticides, Explosives, TOC (sediment), Alkalinity/hardness (surface water), Grain Size Analyses	Collect 3 samples from storm sewer/surface drainage ditch: upstream of site, first depositional area downstream of site, and downstream of second sample.	Previous data suggest potential contaminant transport via storm sewer, surface water.
Site 9 New Egypt Armory	NED/W-01 NED/W-02 NED/W-03	Surface Water Sediment	TCL VOCs, TCL SVOCs, TAL Inorganics, PCBs, TOCs (sediment), TP _H , Alkalinity/hardness (surface water), Grain Size Analyses	Collect samples in stream associated with New Egypt Armory located north of the site.	To assess impacts from surface water runoff and groundwater discharge associated with New Egypt Armory.
Site 10 Range Landfill	N/A	N/A	N/A	N/A	N/A
Site 11 ANC-9 Landfill	N/A	N/A	N/A	N/A	N/A
Site 12 ANC-2 Disposal Area	A2D/A2W-01 A2D/A2W-02 A2D/A2W-03	Surface Water Sediment	TCL VOCs, TCL SVOCs, TAL Metals, PCBs, TOC (sediment), Alkalinity/hardness (surface water), Grain Size Analyses	Collect 3 samples from Bakers Brook	To evaluate potential contamination from landfill material.

TABLE 4
SURFACE WATER/SEDIMENT ASSESSMENT PROGRAM
TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

SITE	SITE ID	MEDIA	CHEMICAL ANALYSES	LOCATION	RATIONALE
Site 13 Boiler Blowdown Area	BBD/W-01 BBD/W-02 BBD/W-03	Surface Water Sediment	TCL VOCs, TCL SVOCs, TAL Inorganics, PCBs, Alkalinity/hardness (surface water), Grain Size Analyses	Collect one sample at outlet of Willow Pond, one sample adjacent to SC-155/156, and one sample approximately 200 feet downstream.	To assess presence/absence of thallium in stream near SC-155/156.
Site 14 Area North of Dogwood Lake	DLD/DLW-01 DLD/DLW-02	Surface Water Sediment	TCL VOCs, TCL SVOCs, TAL Metals, PCBs, TOC (sediment), Alkalinity/hardness (surface water), Grain Size Analyses	Collect two samples from northwest corner of Dogwood Lake	To evaluate potential impact to these media from an identified groundwater plume in the area north of the lake. Data from these two samples will be complemented by SW/SED data from three samples collected for the EI/AA being performed at Fort Dix (ICF-KE, 1993).
Site 15 Golf Course Pesticide Mixing and Storage Area	GPD-01 GPD-02	Sediment	TCL VOCs, TCL SVOCs, TAL Inorganics, PCBs, Herbicides, Pesticides, TOC (sediment), Explosives, TOC (sediment), Alkalinity/hardness (surface water), Grain Size Analyses	Collect two sediment samples from surface drainage from Mixing Area.	To determine if sediments in potential surface water drainage have been impacted by site activities. Surface water/sediment samples for nearby ponds and stream are included in Site 4 Golf Course Leaking Tank Area.

Notes:

TCL VOCs = USEPA Target Compound List of Volatile Organic Compounds

TCL SVOCs = USEPA Target Compound List of Semivolatile Organic Compounds

TAL Metals = USEPA Target Analyte List of Metals

3 Five percent of samples will be collected as duplicates.

4 The number of rinse blanks given represent the anticipated number. Rinse blanks will be collected at a rate of one per type of decontaminated equipment per decontamination event. This rate under the requirements given shall not exceed one rinse blank per day. Rinse blanks will be collected and analyzed for associated parameters. The rinse blank will be collected at the beginning of the day and will accompany the associated samples which are collected during the day.

5 ICAP analytes are: aluminum, iron, magnesium, manganese, silver, sodium, barium, beryllium, cadmium, chromium, cobalt, copper, vanadium, zinc, calcium, GFAA analytes are: arsenic, lead, thallium, silver, selenium. CVAA analyte is Mercury. SPEC analyte is cyanide.

TAL Inorganics = USEPA Target Analyte List of Metals and Cyanide
TOC = Total Organic Carbon

Source:

ICF-KE, 1993

W0109314.T80/3

TABLE 5
SUMMARY OF FIELD SCREENING CHEMICAL ANALYSES FOR GROUNDWATER SAMPLES
TECHNICAL PLAN
FORT DIX RI/S FOR 13 SITES

ANALYTE	METHOD ²	SITE DESIGNATION SITE NO.												NUMBER OF QC SAMPLES					
		PL	PT	GR	TM	AR ⁶	PC	NP ⁶	RL	A ⁹	A ²	BB	DL	GP	SOURCE	FIELD DUPLICATES ³	RINSE BLANKS ⁴	TOTAL SAMPLES	
		2	3	4	5	6	8	9	10	11	12	13	14	H ₂ O	SUMTOTAL				
FIELD SCREENING																			
BTEX	GC	25	105	40	25	24	35	21			54				329	16		345	
Chlor. Sol.	GC		40		35										75	4		79	
TPH	IR	25		40	25	35					54				179	9		188	
Explosives	Immunoassay							21							21	1		22	
Pesticides	GC/ECD														129	6		135	
Herbicides															24	1		25	
Radiation	Gamma scintillator										21	24			45	2		47	
LABORATORY ANALYTICAL																			
TCL VOCs	GC/MS	17	9	43	18	21	12	13	16	3	13				29	2	196	10	135
TCL SVOCs	GC/MS	17	9	43	18	21	12	13	16	3	13				29	2	196	10	35
Pesticides/	GC/ECD			43		12	2								2	59	3	10	72
PCBs																			
Herbicides	GC/ECD																		
TAL	ICAP, GFAA,	40													12	2	56	3	73
Inorganics ⁵	CVAA, SPEC	41													24	22	89	4	43
TAL Metals ²	ICAP, GFAA,	34	18	36	31				60	6	26				58		269	13	42
CVAA																			324
Lead	GFAA			210													210	11	5
Nickel ¹	GFAA																48	3	54
Total Alpha	USEPA:																		33
and Beta	SW-846,																		
Emission	Method 9310																		
	(GFPC)																		
Gamma	USEPA																		
Radiation	EMSL 901.1																		
TPH	USEPA:	5	40	18	21	13					29				2	128	6		161
	MCAWW																		
	418.1(IR)																		
BOD ₅	USEPA:																		
	MCAWW																		
	405.1																		
COD	USEPA:																		
	MCAWW																		
	410.2																		

TABLE 5
SUMMARY OF FIELD SCREENING CHEMICAL ANALYSES FOR GROUNDWATER SAMPLES
TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

ANALYTE	METHOD ²	SITE DESIGNATION/SITE NO.										NUMBER OF QC SAMPLES					
		NUMBER OF SAMPLES ¹										FIELD					
		PL	FT	GT	TM	AR ⁶	PC	NP ⁵	TR	A ⁹	A ²	BB	DL	GP	SOURCE	FIELD	RINSE
TSS	USEPA: MCAWW 160.2									30	3	13	29			287	14
TDS	USEPA: MCAWW 160.1									13						32	2
Alkalinity	USEPA: MCAWW 310.1									13						32	2
Hardness	USEPA: MCAWW 130.2									13						32	2
Explosives	HPLC	9					12		16	3			2			42	2
Nitrate/ Nitrite	USEPA: 353.2	19														19	1
Phosphate	USEPA: 365.4						19									19	1
Sulfate	USEPA: 375.4						19									19	1
																	20

NOTES:

TCL VOCs = USEPA Target Compound List of Volatile Organic Compounds
TCL SVOCs = USEPA Target Compound List of Semivolatile Organic Compounds
TCL Pesticides = USEPA Target Compound List of pesticides
TAL Inorganics = USEPA Target Analyte List (metals and cyanide)
TAL Metals = USEPA Target Analyte List (metals only)

ICAP = Inductively Coupled Argon Plasma

CVAA = Cold Vapor Atomic Absorption

GFAA = Graphite Furnace Atomic Absorption

TPH = Total Petroleum Hydrocarbons

SM = Standard Methods for the Examination of Water and Wastewater

MCAWW = Methods for Chemical Analysis of Water and Wastewater

MCAWW = Methods for Chemical Analysis of Water and Wastewater
SW-846 = Test Methods for Evaluating Solid Waste
GC/MS = Gas Chromatography/Mass Spectrometry
HPLC = High Pressure Liquid Chromatography
GFPC = Gas Flow Proportional Counter
GC/ECD = Gas Chromatography/Electron Capture Detector
IR = Infrared Spectrophotometry
SPEC = Specrofluorometric (cyanide analysis)
CHLOR SOL = Chlorinated Solvents including TCE, 1,1,1-TCA, 1,2-DCE, 1,2-DCA,
1,1-DCE, vinyl chloride, tetrachloroethene, chloroform, and carbon tetrachloride.

¹ Number of samples includes 10% confirmatory analyses for field screening samples, plus analyses of 1 round of samples from existing and proposed monitoring wells.

² Methods used will be those of a USAEFC-certified laboratory, unless otherwise noted.

³ Five percent of samples will be collected as duplicates.

⁴ The number of rinse blanks given represent the anticipated number. Rinse blanks will be collected at a rate of one per type of decontaminated equipment per decontamination event. This rate under the requirements given shall not exceed one rinse blank per day. Rinse blanks will be collected and analyzed for associated parameters. The rinse blank will be collected at the beginning of the day and will accompany the associated samples which are collected during the day. One trip blank (prepared by laboratory) will be sent with each cooler container aqueous samples for VOC analysis. It is estimated that 50 trip blanks will be required for the field program.

⁵ TAL Metals and Inorganics are for both nonfiltered and filtered analyses. ICAP analytes are:

aluminum, iron, magnesium, manganese, nickel, potassium, silver, sodium, barium, beryllium, cadmium, chromium, cobalt, copper, vanadium, zinc, calcium. GFAA analytes are: arsenic, lead, thallium, silver, selenium. CVAA analyte is mercury. SPEC analyte is cyanide.

⁶ This table includes samples FTIDIX-13 production well and UST samples at New Egypt Armory.

TABLE 6
SUMMARY OF FIELD SCREENING AND CHEMICAL AND PHYSICAL ANALYSES FOR SOIL SAMPLES
TECHNICAL PLAN
PORT DIX RIPS FOR 13 SITES

ANALYTE	METHOD	SITE DESIGNATION/SITE NO.										NUMBER OF QC SAMPLES ^a				NUMBER OF QC SAMPLES ^b			
		PL	FI	GT	TM	AR	PC	NH	A9	A2	BB	DL	GP	FIELD DUPLICATES ^c	RINSE BLANKS ^d	TOTAL SAMPLES			
FIELD ANALYTICAL		2	3	4	5	6	7	8	9	10	11	12	13	14	15	SUBTOTAL			
BTEX		40	230		136			96	100				40	30	672	34			
Chlor. Sol.			230					100							330	23			
TPH		40			136			100				40			316	9			
Explosives																0			
Pesticides								96							30	126			
Herbicides								96							30	126			
Radiation								96							0	0			
LABORATORY ANALYTICAL																			
TCL VOC ₃	GC/MS	5	30		23	22	16	24		5	11	4	16	156	9	90	255		
TCL SVOC ₃	GC/MS	5	30		23	22	16	24		5	11	4	16	156	9	45	210		
Pesticides/	GC/ECD						16							16	32	3	13		
PCBs																	48		
Herbicides	GC/ECD						16							16	32	3	5		
TAL	ICAP, GFAA, CVAA, SPEC						16							16	32	4	40		
Inorganics ^e	ICAP, GFAA, CVAA	5	30		23	22	24		5	11	4	124		6	25	69			
TAL Metals ^f														0	2	2			
Total Alpha and Beta Emission	USEPA: SW-846, Method 9310 (GFPC)																155		
Gamma	USEPA: EMSL 901.1													0	2				
Radiation	USEPA: MCIAWW 4181.1(IR)																		
TPH																			
Explosives	HPLC																		
TOC	USEPA: Lloyd Kahn	5	30		23	22	24		5					51	4	13	68		
Grain Size ^g	ASTM D-422	5	5	12	3	2	4	3	1					16	125	8	25		
														4	39	N/A	158		
																	39		

NOTES:

TCL VOC₃ = USEPA Target Compound List of Volatile Organic Compounds

TCL SVOC₃ = USEPA Target Compound List of Semivolatile Organic Compounds

TCL Pesticides = USEPA Target Compound List of pesticides

TAL Inorganics = USEPA Target Analyte List (metals and cyanide)

TAL Metals = USEPA Target Analyte List (metals only)

ICAP = Inductively Coupled Argon Plasma

CVAA = Cold Vapor Atomic Absorption

GFAA = Graphite Furnace Atomic Absorption

TPH = Total Petroleum Hydrocarbons

SM = Standard Methods for the Examination of Water and Wastewater

MCAWW = Methods for Chemical Analysis of Water and Wastewater

SW-846 = Test Methods for Evaluating Solid Waste

GC/MS = Gas Chromatography/Mass Spectrometry

HPLC = High Pressure Liquid Chromatography

GFPIC = Gas Flow Proportional Counter

GC/ECD = Gas Chromatography/Electron Capture Detector

IR = Infrared Spectrophotometry

SPEC = Spectrophotometric (cyanide analysis)

CHLOR SOL = Chlorinated Solvents including TCE, 1,1,1-TCA, 1,2-DCE, 1,2-DCA, 1,1-DCE, vinyl chloride, tetrachloroethylene, chloroform, and carbon tetrachloride.

^a Methods used will be those of a USAEC-certified laboratory, unless otherwise noted.

^b One trip blank (prepared by laboratory) will be sent with each cooler containing a aqueous samples for VOC analysis. Trip blanks will be analyzed for VOCs.

^c Five percent of samples will be collected as duplicates.

^d The number of rinse blanks given represent the anticipated number. Rinse blanks will be collected at a rate of one per type of decontaminated equipment per decontamination event. This rate under the requirements given shall not exceed one rinse blank per day. Rinse blanks will be collected and analyzed for associated parameters. The rinse blank will be collected at the beginning of the day and will accompany samples which are collected during the day.

^e ICAP analytes are: aluminum, iron, magnesium, manganese, nickel, potassium, silver, sodium, barium, beryllium, chromium, cobalt, copper, vanadium, zinc, calcium. GFAA analytes are: arsenic, lead, thallium, silver, selenium. CVAA analyte is cyanide.

^f The number of grain size samples is estimated. One soil sample from the well screen interval of each new monitoring well will be analyzed for grain size.

TABLE 7
SUMMARY OF FIELD SCREENING CHEMICAL ANALYSES FOR SURFACE WATER SAMPLES

TECHNICAL PLAN
FORT DIX RIFFS FOR 13 SITES

ANALYTE	METHOD ¹	SITE DESIGNATION/SITE NO.												NUMBER OF QC SAMPLES ²				TOTAL SAMPLES			
		PL	FT	GT	TM	AR	FC	NE	RL	A9	A2	BB	DL	GP	15	RINSE BLANKS ⁴	DUPPLICATES ³	FIELD BLANKS			
FIELD ANALYTICAL																					
BTEX																		3	1		
Chlor. Sol.																		3	1		
TPH																		3	1		
Explosives																		0	0		
Pesticides																		0	0		
Herbicides																		0	0		
Radiation																		0	0		
LABORATORY ANALYTICAL																					
TCL VOC ₃	GC/MS	5	5	9	8	3	3	3	3	3	3	2	2	43	3	15	3	15			
TCL SVOC ₃	GC/MS	5	5	8	3	3	3	3	3	3	3	2	2	43	3	15	3	15			
Pesticides/	GC/ECD	5	5	9	8	3	3	3	3	3	2	2	2	43	3	10	3	10			
PCBs																		56			
Herbicides	GC/ECD	9	9	3	3																
TAL	ICAP, GFAA,	9	9	3	3																
Inorganics ⁵	CVAA, SPEC																				
TAL Metals ⁵	ICAP, GFAA,	5	5	8	3	3	3	3	3	2	2	2	2	29	2	8	8				
	CVAA																	39			
Total Alpha	USEPA: SW-846, and Beta Emission														0			0			
	Method 9310 (GFPC)																				
Gamma	USEPA: EMSL 901.1														0			0			
Radiation	TPH	USEPA: MCAWW 418.1 (IR)				8	3								11	1	1	3			
Explosives	HPLC	5	5	3	3	3	3	3	3	3	2	2	8	1	3	15	3	15			
Alkalinity/ Hardness	USEPA: MCAWW 310.1 & 130.2																				
TSS	USEPA MCAWW									3											
	160.2																				

NOTES:
TCL VOC₃ = USEPA Target Compound List of Volatile Organic Compounds
TCL SVOC₃ = USEPA Target Compound List of Semivolatile Organic Compounds
TCL Pesticides = USEPA Target Compound List of pesticides
TAL Inorganics = USEPA Target Analyte List (metals and cyanide)
TAL Metals = USEPA Target Analyte List (metals only)
SW - 846 = Test Methods for Evaluating Solid Waste
GC/MS = Gas Chromatography/Mass Spectrometry
ICAP = Inductively Coupled Argon Plasma
CVAA = Cold Vapor Atomic Absorption
GFAA = Graphite Furnace Atomic Absorption

- Methods used will be those of a USAEC-certified laboratory, unless otherwise noted.
- One trip blank (prepared by laboratory) will be sent with each cooler containing aqueous samples for VOC analysis. ICAP analytes are:
- Five percent of samples will be collected as duplicates.
- Rinse blanks are included in Table 8.

⁵ TAL Metals and inorganics are for total analyses only. No dissolved analyses will be conducted on these samples. ICAP analytes are: aluminum, iron, magnesium, manganese, nickel, potassium, silver, sodium, barium, beryllium, cadmium, chromium, cobalt, copper, vanadium, zinc, calcium. GFAA analytes are: arsenic, lead, thallium, silver, selenium. CVAA analyte is mercury. SPEC analyte is cyanide.

TPH = Total Petroleum Hydrocarbons
SM = Standard Methods for the Examination of Water and Wastewater
MCAWW = Methods for Chemical Analysis of Water and Wastewater
HPLC = High Pressure Liquid Chromatography
GFPC = Gas Flow Proportional Counter
GC/ECD = Gas Chromatography/Electron Capture Detector
IR = Infrared Spectrophotometry
SPEC = Spectrophotometric (cyanide analysis)
CHLOR SCL = Chlorinated Solvents including TCE, 1,1,1-TCA, 1,2-DCE, 1,2-DCA, 1,1-DCE, vinyl chloride, tetrachloroethene, chloroform, and carbon tetrachloride.

TABLE 8
SUMMARY OF FIELD SCREENING CHEMICAL AND PHYSICAL ANALYSES FOR SEDIMENT SAMPLES
QUALITY ASSURANCE PROJECT PLAN
FORT DIX RIFTS FOR 13 SITES

ANALYTE	METHOD ¹	SITE DESIGNATION/SITE NO.												NUMBER OF QC SAMPLES				
		PL	FT	GT	TM	AR	PC	NE	PL	A9	A2	BB	DL	GP	15	DUPPLICATES		
FIELD	ANALYTICAL	2	3	4	5	6	7	9	10	11	12	13	14	15	NUMBER OF QC SAMPLES	RINSE	TOTAL	
BTEX															3	1	0	
Chlor. Sol.															3	1	0	
TPH															3	1	0	
LABORATORY ANALYTICAL																		
TCL VOC ₃	GC/MS	5	5	9		8	3	6				3	3	2	2	46	3	30
TCL SVOCs	GC/MS	5	5	9		8	3	6				3	3	2	2	46	3	15
Pesticides / PCBs	GC/ECD	5	5	9		8	3	6				3	3	2	2	46	2	7
Herbicides	GC/ECD																	55
TAL Inorganics ⁵	ICAP, GFAA, CVAA, SPEC	9				3												7
TAL Metals ⁵	ICAP, GFAA, CVAA	5	5			8												22
Total Alpha and Beta Emission	USEPA: SW-846, Method 9310 (GFPC)					6				3	3	2						22
Gamma Radiation	USEPA: EMSL 901.1																	49
TPH	USEPA: MCAWW 418.1 (IR)					8												1
Explosives	HPLC																	1
TOC	USEPA: Lloyd Kahn	5	5	9		8	3	6		3	3	2						1
Grain Size ⁶	ASTM D-422	5	5	9		8	3	6		3	3	2	2	46	3	3	3	52

NOTES:

TCL VOCs = USEPA Target Compound List of Volatile Organic Compounds

TCL SVOCs = USEPA Target Compound List of Semivolatile Organic Compounds

TCL Pesticides = USEPA Target Compound List of pesticides

TAL Inorganics = USEPA Target Analyte List (metals and cyanide)

TAL Metals = USEPA Target Analyte List (metals only)

ICAP = Inductively Coupled Argon Plasma

CVAA = Cold Vapor Atomic Absorption

GFAA = Graphite Furnace Atomic Absorption

TPH = Total Petroleum Hydrocarbons

Chlor. Sol. =

MCAWW = Methods for Chemical Analysis of Water and Wastewater

SW-846 = Test Methods for Evaluating Solid Waste

GC/MS = Gas Chromatography/Mass Spectrometry

HPLC = High Pressure Liquid Chromatography

GFPC = Gas Flow Proportional Counter

GC/ECD = Gas Chromatography/Electron Capture Detector

IR = Infrared Spectrophotometry

SPEC = Spectrophotometric (cyanide analysis)

SM = Standard Methods for the Examination of Water and Wastewater

CHLOR SOL = Chlorinated Solvents including TCE, 1,1,1-TCA, 1,2-DCE, 1,2-DCA, 1,1-DCE, vinyl chloride, tetrachloroethene, chloroform, and carbon tetrachloride.

¹ Methods used will be those of a USAEC-certified laboratory, unless otherwise noted.

² One trip blank (prepared by laboratory) will be sent with each cooler containing aqueous samples for VOC analysis. Trip blanks will be analyzed for VOCs.

³ Five percent of samples will be collected as duplicates.

⁴ The number of rinse blanks given represent the anticipated number. Rinse blanks will be collected at a rate of one per type of decontaminated equipment per decontamination event. This rate under the requirements given shall not exceed one rinse blank per day. Rinse blanks will be collected and analyzed for associated parameters. The rinse blank will be collected at the beginning of the day and will accompany the associated samples which are collected during the day.

⁵ ICAP analyses are: aluminum, iron, magnesium, manganese, nickel, potassium, sodium, barium, beryllium, cadmium, chromium, cobalt, copper, vanadium, zinc, calcium. GFAA analyses are: arsenic, lead, thallium, silver, selenium. CVAA analyses are mercury. SPEC analysis is cyanide.

⁶ Grain size analysis will be performed on sediment samples.

TABLE 9
PROJECT ANALYTE LIST

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

ANALYTE GROUP	ANALYTICAL METHOD	ANALYTE	TCL/TAL ANALYTE
VOCs	GC/MS	1,2-Dichloroethenes/1,2-Dichloroethylenes (cis and trans isomers)	✓
		trans-1,3-Dichloropropene	✓
		Ethylbenzene	✓
		Styrene/Ethylbenzene/Styrol/Styrolene/Cinnamene/Cinnamol/Phenylethylene/Vinylbenzene	✓
		1,2-Dichloroethane	✓
		Methyl isobutyl ketone/Isopropylacetone/4-Methyl-2-pentanone	✓
		Toluene	✓
		Chlorobenzene/Monochlorobenzene	✓
		cis-1,3-Dichloropropene/cis-1,3-Dichloropropylene	✓
		Xylenes	✓
		Dibromochloromethane/Chlorodibromomethane	✓
		Tetrachloroethene/Tetrachloroethylene/Perchloroethylene/Ethylene tetrachloride/Nema/Tetrapac/Tetropil	✓
		Carbon tetrachloride	✓
		Acetone	✓
		Chloroform	✓
		Benzene	✓
		1,1,1-Trichloroethane	✓
		Bromomethane	✓
		Chloromethane	✓
		Chloroethane	✓
		Chloroethene/Vinyl chloride	✓
		Methylene chloride/Dichloromethane	✓
		Carbon disulfide	✓

TABLE 9
PROJECT ANALYTE LIST

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

ANALYTE GROUP	ANALYTICAL METHOD	ANALYTE	TCL/TAL ANALYTE
VOCs (cont.)	GC/MS	Bromoform	✓
		Bromodichloromethane	✓
		1,1-Dichloroethene/1,1-Dichloroethylene	✓
		1,1-Dichloroethane	✓
		1,2-Dichloropropane	✓
		2-Butanone/Methyl ethyl ketone	✓
		1,1,2-Trichloroethane	✓
		Trichloroethene/Trichloroethylene/Ethynyl trichloride/Tri-Clene/Trielene/Trilene	✓
		1,1,2,2-Tetrachloroethane/Tetrachloroethane/Acetylene tetrachloride/Cellon/Bonoform	✓
		2-Hexanone/Methyl n-butyl ketone	✓
SVOCS	GC/MS	4-Bromophenyl phenyl ether	✓
		4-Chlorophenyl phenyl ether	✓
		4-Nitroaniline	✓
		4-Nitrophenol	✓
		2,4-Dimethylphenol	✓
		Benzo[b]fluoranthene/3,4-Benzofluoranthene	✓
		2,6-Dinitrotoluene	✓
		Fluoranthene	✓
		4-Cresol/4-Methylphenol/p-Cresol	✓
		1,4-Dichlorobenzene	✓
		4-Chloroaniline	✓
		Benzo[k]fluoranthene	✓
		Bis(2-chloroisopropyl) ether/2,2'-oxybis(1-chloropropane)	✓
		Phenol/Carbolic acid/Phenic acid/Phenyllic acid/Phenyl hydroxide/Hydroxybenzene/Oxybenzene	✓

TABLE 9
PROJECT ANALYTE LIST

**TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES**

ANALYTE GROUP	ANALYTICAL METHOD	ANALYTE	TCL/TAL ANALYTE
SVOCs (cont.)	GC/MS	Acenaphthylene	✓
		Bis(2-chloroethyl) ether	✓
		Bis(2-chloroethoxy) methane	✓
		Bis(2-ethylhexyl) phthalate	✓
		Di-n-octyl phthalate	✓
		Chrysene	✓
		Hexachlorobenzene	✓
		Anthracene	✓
		1,2,4-Trichlorobenzene	✓
		2,4-Dichlorophenol	✓
		2,4-Dinitrotoluene	✓
		N-Nitrosodi-n-propylamine	✓
		Pyrene/Benzo[def]phenanthrene	✓
		Dimethyl phthalate	✓
		Dibenzofuran	✓
		2-Methyl-4,6-dinitrophenol/4,6-Dinitro-2-methylphenol	✓
		1,3-Dichlorobenzene	✓
		Benzo[a]pyrene	✓
		2,4-Dinitrophenol	✓
		Dibenz[ah]anthracene/1,2:5,6-Dibenzanthracene	✓
		Benzo[a]anthracene	✓
		3-Methyl-4-chlorophenol/4-Chloro-3-cresol/ 4-Chloro-3-methylphenol/4-Chloro-m-cresol	✓
		Hexachloroethane	✓
		Hexachlorocyclopentadiene	✓
		Isophorone	✓
		Acenaphthene	✓

TABLE 9
PROJECT ANALYTE LIST

**TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES**

ANALYTE GROUP	ANALYTICAL METHOD	ANALYTE	TCL/TAL ANALYTE
SVOCs (cont.)	GC/MS	Diethyl phthalate	✓
		Di-n-butyl phthalate	✓
		Phenanthrene	✓
		Butylbenzyl phthalate	✓
		N-Nitrosodiphenylamine	✓
		Fluorene/9H-Fluorene	✓
		9H-Carbazole/Carbazole	✓
		Hexachloro-1,3-butadiene/Hexachlorobutadiene	✓
		Pentachlorophenol	✓
		2,4,6-Trichlorophenol	✓
		2-Nitroaniline	✓
		2-Nitrophenol	✓
		Naphthalene/Tar camphor	✓
		Benzo[ghi]perylene	✓
		2-Methylnaphthalene	✓
		2-Chloronaphthalene	✓
		3,3'-Dichlorobenzidine	✓
		Indeno[1,2,3-C,D]pyrene	✓
		2-Cresol/2-Methylphenol/o-Cresol	✓
		1,2-Dichlorobenzene	✓
		2-Chlorophenol	✓
		2,4,5-Trichlorophenol	✓
		Nitrobenzene/Essence of mirbane/Oil of mirbane	✓
		3-Nitroaniline	✓

TABLE 9
PROJECT ANALYTE LIST

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

ANALYTE GROUP	ANALYTICAL METHOD	ANALYTE	TCL/TAL ANALYTE
PESTICIDES	GC/ECD	Toxaphene/Chlorinated camphene/Camphechlor/ Alltox/Genephene/Motox/Penphene/Phenacide/ Phenatox/	✓
		alpha-Chlordane	✓
		Aldrin	✓
		beta-Endosulfan/Endosulfan II	✓
		alpha-Benzenehexachloride/ alpha-Hexachlorocyclohexane	✓
		beta-Benzenehexachloride/ beta-Hexachlorocyclohexane	✓
		delta-Benzenehexachloride/ delta-Hexachlorocyclohexane	✓
		Endrin aldehyde	✓
		Heptachlor epoxide	✓
		Endosulfan sulfate	✓
		2,2-Bis(p-chlorophenyl)-1,1,1-trichloroethane (4,4'-DDT)	✓
		gamma-Benzenehexachloride/gamma- Hexachlorocyclohexane/Lindane	✓
		alpha-Endosulfan/Endosulfan I	✓
		Dieldrin	✓
		gamma-Chlordane	✓
		Endrin	✓
		Methoxychlor/Methoxy-DDT/1,1'-(2,2,2- Trichloroethylidene)-bis[4-methoxybenzene]	✓
		1,1-Dichloro-2,2-bis(p-chlorophenyl)ethane/Rhothane/ TDE/ppDDD/1,1'-(2,2-Dichloroethylidene)bis[4- chlorobenzene]	✓
		2,2-Bis(p-chlorophenyl)-1,1-dichloroethene (4,4'-DDE)	✓
		Heptachlor/1H-1,4,5,6,7,8,8-Heptachloro-3a,4,7,	✓
Endrin ketone	✓		

TABLE 9
PROJECT ANALYTE LIST

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

ANALYTE GROUP	ANALYTICAL METHOD	ANALYTE	TCL/TAL ANALYTE
HERBICIDES	GC/ECD	2,4-D	
		2,4-DB	
		2,4,5-T	
		2,4,5-TP	
		Dalapon	
		Dicamba	
		Dichloroprop	
		Dinoseb	
		MCPA	
		MCPP	
EXPLOSIVES	HPLC	2,6-Dinitrotoluene	✓
		2,4,6-Trinitrotoluene/alpha-Trinitrotoluene	
		2,4-Dinitrotoluene	✓
		RDX/Cyclonite/Hexahydro-1,3,5-trinitro-1,3,5-triaz Hexogen	
		Nitroglycerine/1,2,3-Propanetriol trinitrate	
		PETN/Pentaerythritol tetranitrate/2,2-Bis[(nitroox methyl]-1,3-propanediol dinitrate (ester)	
		Tetryl/N-Methyl-N,2,4,6-tetranitroaniline/Nitramine	
		HMX/Cyclotetramethylenetrinitramine	
		Nitrobenzene/Essence of mirbane/Oil of mirbane	✓
		1,3,5-Trinitrobenzene	
		1,3-Dinitrobenzene	
INORGANICS	CVAA	Mercury	✓
	GFAA	Selenium	✓
	GFAA	Lead	✓
	GFAA	Arsenic	✓

TABLE 9
PROJECT ANALYTE LIST

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

ANALYTE GROUP	ANALYTICAL METHOD	ANALYTE	TCL/TAL ANALYTE
INORGANICS (Cont.)	GFAA	Thallium	✓
	GFAA	Antimony	✓
	ICAP	Aluminum	✓
		Iron	✓
	ICAP	Magnesium	✓
		Manganese	✓
		Nickel	✓
		Potassium	✓
		Silver	✓
		Sodium	✓
		Barium	✓
		Beryllium	✓
		Cadmium	✓
		Chromium	✓
		Cobalt	✓
		Copper	✓
		Vanadium	✓
		Zinc	✓
		Calcium	✓
	Spectrophotometric	Cyanide	✓
OIL & GREASE	Infrared	Oil & Grease	
TPH	Infrared	Total Petroleum Hydrocarbons	
TOC	Combustion	Total Organic Carbon	
BOD ₅	Probe	Biochemical Oxygen Demand	
COD	Titrimetric	Chemical Oxygen Demand	
TSS	Gravimetric	Total Suspended Solids	

TABLE 9
PROJECT ANALYTE LIST

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

ANALYTE GROUP	ANALYTICAL METHOD	ANALYTE	TCL/TAL ANALYTE
TDS	Gravimetric	Total Dissolved Solids	
ALKALINITY	Titrimetric	Alkalinity	
HARDNESS	Titrimetric	Hardness	
GROSS ALPHA	Scintillation Counter	Gross Alpha Radiation	
GROSS BETA	Scintillation Counter	Gross Beta Radiation	
GAMMA RADIATION	Gamma Spectrometer	Gamma Radiation	

Notes:

TCL = Target Compound List
 TAL = Target Analyte List
 VOC = volatile organic compound
 SVOC = semivolatile organic compound
 GC/MS = Gas Chromatography/Mass Spectrometry
 GC/ECD = Gas Chromatography/Electron Capture Detector
 HPLC = High Pressure Liquid Chromatography
 CVAA = Cold Vapor Atomic Absorption
 GFAA = Graphite Furnace Atomic Absorption
 ICAP = Inductively Coupled Argon Plasma

TABLE 10
INFORMATION REQUIRED FOR GEOTECHNICAL AND CHEMICAL DATA ENTRY INTO IRDMIS

**QUALITY ASSURANCE PROJECT PLAN
FORT DIX RI/FS FOR 13 SITES**

IRDMIS DATA ENTRY ELEMENTS	GEOTECHNICAL DATA ENTRY	CHEMICAL DATA ENTRY
Installation	X	X
Laboratory		X
Sample		X
Test Method		X
Measurement Units		X
Analyst		X
Sample Number		X
File Name	X	X
File Site Type	X	X
Site ID	X	X
Field Sampler Number	X	X
Sample Date	X	X
Sample Program	X	
Sample Depth (cm)	X	
Sample Technique	X	
Lab Analysis Number		X
Sample Preparation Date		X
Analysis Date		X
Test Name		X
Measurement Boolean		X
Uncorrected Measurement Value		X
Dilution Factor		X
Percent Moisture		X
Internal Standard Code		X
QC Test		X
QC Spike Value		X

Source: ICF Kaiser Engineers, 1993b

TABLE 11
**APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) AND OTHER
 GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN: GROUNDWATER ($\mu\text{G}/\text{L}$)**

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

CHEMICAL	FEDERAL MAXIMUM CONTAMINANT LEVELS ($\mu\text{G}/\text{L}$)	MAXIMUM CONTAMINANT LEVEL GOALS	DRINKING WATER HEALTH ADVISORY FOR LIFETIME EXPOSURE	OTHER FEDERAL GUIDANCE ($\mu\text{G}/\text{L}$)		NEW JERSEY GROUNDWATER STANDARDS (A) CLASS I-PINELANDS GROUNDWATER	LOC ($\mu\text{G}/\text{L}$)	CRL ($\mu\text{G}/\text{L}$)	COD ($\mu\text{G}/\text{L}$)	USAEC GROUNDWATER
					SECONDARY MAXIMUM CONTAMINANT LEVELS					
ORGANICS										
Benzene	5 (f)	0 (f)	-	-	-	Zero	1	0.5	0.25	
bis(2-Chloroisopropyl)ether	-	-	300 (bb)	-	-	Zero	14.8	5.3	2.65	
Bromoform	100 (f,k)	-	-	-	-	Zero	0.8	2.6	1.3	
Bromomethane	-	-	10 (bb)	-	-	Zero	-	5.8	2.9	
Carbon tetrachloride	5 (f)	0 (f)	-	-	-	Zero	2	0.58	0.29	
Carcinogenic PAHs [benzo(a)pyrene]	0.2 (b,c)	0 (b,c)	-	-	-	Zero	15.5	4.7	2.35	
Chlordane	2 (d)	0 (d)	-	-	-	Zero	0.5	0.265	0.13	
Chlorobenzene	100 (d)	100 (d)	300 (j)	-	-	Zero	2	0.5	0.25	
Chloroform	100 (f,k)	-	-	-	-	Zero	1	0.5	0.25	
Chromomethane	-	-	3 (bb)	-	-	Zero	-	3.2	1.6	
cis-1,2-Dichloroethene	70 (d)	70 (d)	70 (bb)	-	-	Zero	2	0.5	0.25	

TABLE 11
**APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) AND OTHER
 GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN: GROUNDWATER ($\mu\text{G}/\text{L}$)**

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

CHEMICAL	OTHER FEDERAL GUIDANCE ($\mu\text{G}/\text{L}$)			USAEC GROUNDWATER				
	FEDERAL MAXIMUM CONTAMINANT LEVELS ($\mu\text{G}/\text{L}$)	DRINKING WATER HEALTH ADVISORY FOR LIFETIME EXPOSURE	SECONDARY MAXIMUM CONTAMINANT LEVELS	NEW JERSEY GROUNDWATER STANDARDS (A)	CLASS I-PINELANDS GROUNDWATER	CRL ($\mu\text{G}/\text{L}$)		
1,2-Dichlorobenzene	600 (d)	600 (d)	620 (j)	10 (b,r)	Zero	5	1.7	0.85
1,3-Dichlorobenzene	-	-	620 (j)	-	Zero	5	1.7	0.85
1,4-Dichlorobenzene	75 (f)	75 (f)	75 (j)	5 (b,r)	Zero	5	1.7	0.85
1,2-Dichloroethane	5 (f)	0 (f)	-	-	Zero	2	0.50	0.25
1,1-Dichloroethene	7 (f)	7 (f)	7 (bb)	-	Zero	2	0.50	0.25
Dichloromethane	5	0	-	-	Zero	5	2.3	1.15
1,2-Dichloropropane	5 (d)	0 (d)	-	-	Zero	1	0.50	0.25
Diethylhexylphthalate	6 (c)	0 (c)	-	-	Zero	0.04	4.8	2.4
Endrin	0.2 (f), 2 (b,c)	2 (b,c)	2 (bb)	-	Zero	5	0.0238	0.119
Ethylbenzene	700 (d)	700 (d)	700 (bb)	30 (b,r)	Zero	0.4	0.5	0.25
Gamma-BHC (lindane)	0.2 (d)	0.2 (d)	0.2 (bb)	-	Zero	0.2	0.0507	0.025
Heptachlor	0.4 (d)	0 (d)	-	-	Zero	5	0.0423	0.021

TABLE 11
**APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) AND OTHER
 GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN: GROUNDWATER ($\mu\text{G}/\text{L}$)**

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

CHEMICAL	OTHER FEDERAL GUIDANCE ($\mu\text{G}/\text{L}$)			USAEC GROUNDWATER				
	FEDERAL MAXIMUM CONTAMINANT LEVELS ($\mu\text{G}/\text{L}$)	DRINKING WATER HEALTH ADVISORY FOR LIFETIME EXPOSURE	SECONDARY MAXIMUM CONTAMINANT LEVELS	NEW JERSEY GROUNDWATER STANDARDS (A) CLASS I-PINELANDS GROUNDWATER	LOC ($\mu\text{G}/\text{L}$)	CRL ($\mu\text{G}/\text{L}$)	COD ($\mu\text{G}/\text{L}$)	
Heptachlor epoxide	0.2 (d)	0 (d)	-	-	Zero	0.2	0.245	0.12
Hexachlorobenzene	1 (b,c)	0 (b,c)	-	-	Zero	10	1.6	0.8
Hexachlorobutadiene	-	-	0.1 (bb)	-	Zero	1	3.4	1.7
Hexachlorocyclopentadiene (HEX)	50 (b,c)	50 (b,c)	-	8 (b,c)	Zero	10	8.6	4.3
Methoxychlor	40 (d)	40 (d)	40 (bb)	-	Zero	10	0.057	0.029
Methylene chloride (dichloromethane)	5 (b,c)	0 (b,c)	-	-	Zero	2	2.3	1.15
Naphthalene	-	-	20 (t)	-	Zero	20	0.5	0.25
Pentachlorophenol	1 (l)	0 (l)	-	-	Zero	1	1.19	0.59
Polychlorinated Biphenyls (PCBs)	0.5 (d)	0 (d)	-	-	Zero	0.5	0.16	0.08
Styrene	100 (d)	100 (d)	100 (bb)	-	Zero	5	0.5	0.25
Tetrachloroethene	5 (d)	0 (d)	-	-	Zero	1	1.6	0.8

TABLE 11
**APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) AND OTHER
 GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN: GROUNDWATER ($\mu\text{G}/\text{L}$)**
TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

CHEMICAL	FEDERAL MAXIMUM CONTAMINANT LEVELS ($\mu\text{G}/\text{L}$)	OTHER FEDERAL GUIDANCE ($\mu\text{G}/\text{L}$)		USAEC GROUNDWATER				
		DRINKING WATER HEALTH ADVISORY FOR LIFETIME EXPOSURE	SECONDARY MAXIMUM CONTAMINANT LEVELS	NEW JERSEY GROUNDWATER STANDARDS (A) CLASS I-PINELANDS GROUNDWATER	LOC ($\mu\text{G}/\text{L}$)	CRL ($\mu\text{G}/\text{L}$)	COD ($\mu\text{G}/\text{L}$)	
Toluene	1,000 (d)	1,000 (d)	1,000 (bb)	-	Zero	5	0.5	0.25
Toxaphene	3 (d)	0 (d)	-	-	Zero	3	1.35	0.68
trans-1,2-Dichloroethene	100 (d)	100 (d)	-	-	Zero	2	0.5	0.25
1,2,4-Trichlorobenzene	70 (b,c)	70 (b,c)	70 (bb)	-	Zero	1	1.8	0.9
1,1,1-Trichloroethane	200 (f)	200 (f)	200 (bb)	-	Zero	1	0.5	0.25
1,1,2-Trichloroethane	5 (c)	3 (c)	3 (bb)	-	Zero	2	1.2	0.6
Trichloroethene	5 (f)	0 (f)	-	-	Zero	1	0.5	0.25
Vinyl chloride	2 (f)	0 (f)	-	-	Zero	5	2.6	1.3
Xylenes	10,000 (d)	10,000 (d)	10,000 (bb)	-	Zero	2	0.84	0.42
INORGANICS								
Aluminum	-	-	-	50-200 (d)	Background	200	141.0	70.5
Antimony	6 (b,c,e)	6 (b,c)	3 (bb)	-	Background	20	3.03	1.575

TABLE 11
**APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) AND OTHER
 GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN: GROUNDWATER ($\mu\text{G}/\text{L}$)**
TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

CHEMICAL	FEDERAL MAXIMUM CONTAMINANT LEVELS ($\mu\text{G}/\text{L}$)	OTHER FEDERAL GUIDANCE ($\mu\text{G}/\text{L}$)		USAEC GROUNDWATER				
		MAXIMUM CONTAMINANT LEVEL GOALS	DRINKING WATER HEALTH ADVISORY FOR LIFETIME EXPOSURE	SECONDARY MAXIMUM CONTAMINANT LEVELS	NEW JERSEY GROUNDWATER STANDARDS (A) CLASS I-PINELANDS GROUNDWATER	LOC ($\mu\text{G}/\text{L}$)	CRL ($\mu\text{G}/\text{L}$)	COD ($\mu\text{G}/\text{L}$)
Arsenic	50 (f)	-	-	-	Background	8	2.54	1.27
Barium	2,000 (l,h)	2,000 (l)	2,000 (bb)	-	Background	200	5.0	2.5
Beryllium	(4,c)	(4,c)	-	-	Background	20	5.0	2.5
Cadmium	5 (d)	5 (d)	5 (bb)	-	Background	2	4.01	2.00
Chromium	100 (d)	100 (d)	120 (bb)	-	Background	10	6.02	3.01
Copper	1,300 (o,p)	1,300 (p)	-	1,000 (q)	Background	1,000	8.09	4.04
Cyanide	200 (b,c)	200 (b,c)	200 (bb)	-	Background	40	2.5	1.25
Iron	-	-	-	300 (bb)	Background	100	38.8	19.4
Lead	15 (o,p)	0 (p)	-	-	Background	10	1.26	0.63
Manganese	-	200 (bb)	-	50 (bb)	Background	6	2.75	1.38
Mercury	2 (d)	2 (d)	2 (bb)	-	Background	1	0.243	0.12
Nickel	100 (b,c)	100 (b,c)	100 (bb)	-	Background	10	34.3	17.15

TABLE 11
**APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) AND OTHER
 GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN: GROUNDWATER ($\mu\text{G}/\text{L}$)**

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

CHEMICAL	OTHER FEDERAL GUIDANCE ($\mu\text{G}/\text{L}$)			USAEC GROUNDWATER			
	FEDERAL MAXIMUM CONTAMINANT LEVELS ($\mu\text{G}/\text{L}$)	DRINKING WATER HEALTH ADVISORY FOR LIFETIME EXPOSURE	SECONDARY MAXIMUM CONTAMINANT LEVELS	NEW JERSEY GROUNDWATER STANDARDS (A)	CLASS I-PINELANDS GROUNDWATER	CRL LOC ($\mu\text{G}/\text{L}$)	COD ($\mu\text{G}/\text{L}$)
Selenium	50 (d)	50 (d)	-	-	Background	10	3.02
Silver	-	-	-	100 (bb)	Background	2	0.25
Thallium	2 (c,x)	0.5 (b,c)	0.4 (bb)	-	Background	10	6.99
Zinc	-	-	2,000 (bb)	5,000 (bb)	Background	30	21.1
							10.55

Notes:

- = Standard not developed for this chemical.
- CRL = USAEC Certified Reporting Limit
- COD = USAEC Criteria of Detection, extended detection limits = 0.5^*CRL
- LOC = Level of Concern. Defined as NJDEP GW-1 PQL, unless otherwise noted. Groundwater Quality Standards (NJDEP, 1993 N.J.A.C. 7:9-6).
- (a) For Class 1 - Pinelands (Protection Area) groundwater, the groundwater cleanup for a contaminant shall be the background groundwater concentration of that contaminant (24 New Jersey Register 389, February 3, 1992).
- (b) Proposed Environmental Protection Agency (EPA). 1990. National Primary and Secondary Drinking Water Regulations; Synthetic Organic Chemicals and Inorganic Chemicals. Proposed Rule. Federal Register. Vol. 53, No. 143, Wednesday, July 25, 1990.
- (c) Environmental Protection Agency (EPA), 1991. National Primary Drinking Water Regulations; Final Rule. Federal Register. Vol. 56, No. 20, Wednesday, January 30, 1991. 3526-3597.
- (d) EPA proposes MCLs of $10 \mu\text{g}/\text{l}$ and $5 \mu\text{g}/\text{l}$ for antimony based on proposed practical quantitation levels (PQLs).
- (e) 40 CFR, Part 141-National Primary Drinking Water Regulations, 559-563, 620-621.
- (f)

Table 11 Notes

(g) Environmental Protection Agency (EPA), 1985. National Primary Drinking Regulations. Synthetic Organic Chemicals, Inorganic Chemicals and Microorganisms. Proposed Rule. Federal Register, Vol. 50, No. 219, Wednesday, November 13, 1985. 46935-47025.

(h) The MCL for barium of 1,000 µg/l shall remain effective until January 1, 1993 when the MCL of 2,000 µg/l will take its place.

(i) Environmental Protection Agency (EPA), 1991. National Primary Drinking Water Regulations - Monitoring for Volatile Organic Chemicals; MCLGs and MCLs for Aldicarb, Aldicarb Sulfoxide, Aldicarb Sulfone, Pentachlorophenol, and Barium; Final Rule. Federal Register. Vol. 56, No. 126, Monday, July 1, 1991. 30266-30281.

(j) Environmental Protection Agency (EPA), 1987. Health Advisoris, Office of Drinking Water, Washington, D.C. March 31, 1987.

(k) The value of 100 µg/liter is for total trihalomethanes (i.e., the sum of chloroform, bromochloromethane, and bromoform).

(l) Environmental Protection Agency (EPA), 1989. Health Advisory of Bromomethane. Office of Drinking Water, Washington, D.C. September, 1989.

(m) Environmental Protection Agency (EPA), 1989. Health Advisory for bis(2-Chloroisopropyl)ether. Office of Drinking Water, Washington, D.C. September, 1989.

(n) Environmental Protection Agency (EPA), 1989. Health Advisory for Chloromethane. Office of Drinking Water, Washington, D.C. October, 1989.

(o) Action Level; exceeded if the level of concentration in more than 10 percent of the targeted tap samples is greater than the specified value (90th percentile).

(p) Standards effective December 7, 1992. Environmental Protection Agency (EPA), 1991. Drinking Water Regulations; Maximum Contaminant Level Goals and National Primary Drinking Water Regulations for Lead and Copper; Final Rule. Federal Register, Vol. 56, No. 110, 26460-26564, Friday, June 7, 1991.

(q) 40 CFR, Part 143-National Secondary Drinking Water Regulations. 674.

(r) Environmental Protection Agency (EPA), 1989. National Primary and Secondary Drinking Water Regulations; Proposed Rule. Federal Register. Vol. 54, No. 97, Monday, May 22, 1989. 22062-22160.

(s) Environmental Protection Agency (EPA), 1989. Health Advisory for Hexachlorobutadiene, Office of Drinking Water, Washington D.C., September 1989.

(t) Environmental Protection Agency (EPA), 1990. Health Advisory for Naphthalene, Office of Drinking Water. Washington, D.C. March, 1990.

(x) EPA proposes MCLs of 2 µg/l and 1 µg/l for thallium based on proposed practical quantitation levels (PQLs).

(aa) The MCL for lead is in effect until December 7, 1992, when the Action Level will take its place.

(bb) Environmental Protection Agency (EPA), 1992. Drinking Water Regulations and Health Advisories. Office of Water, Washington D.C.

(cc) CRL/COD listed applies specifically to benzo(a)pyrene.

TABLE 12
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)
AND OTHER GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN: SURFACE WATER ($\mu\text{G}/\text{L}$)

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

ANALYTE	FEDERAL SURFACE WATER QUALITY CRITERIA ($\mu\text{G}/\text{L}$)				USAECA SURFACE WATER		
	FRESHWATER ACUTE CRITERIA	FRESHWATER CHRONIC CRITERIA	WATER AND FISH INGESTION	FISH CONSUMPTION ONLY	PROPOSED STATE SURFACE WATER QUALITY CRITERIA FOR FW2 WATERS	LOC ($\mu\text{G}/\text{L}$)	CRL ($\mu\text{G}/\text{L}$)
					NC	10	1.7
Acenaphthene	*1,700	*520	NC	NC	0.0028 (hc)	10	0.5
Acenaphthylene	NC	NC	NC	NC	0.00028 (hc)	10	0.5
Aldrin	3.0	NC	0.074x10 ⁻³	0.079x10 ⁻³	3.0 (a); 0.000135 (hc)	0.04	0.092
Anthracene	NC	NC	NC	NC	9.570 (h)	10	0.5
Benzo[a]anthracene ^d	NC	NC	2.8x10 ⁻³	31.1x10 ⁻³	0.0028 (hc)	10	1.6
Benzene	5,300	NC	**0.66	**40.0	13.5 (h)	7	0.5
Benzo[a]pyrene ^d	NC	NC	2.8x10 ⁻³	31.1x10 ⁻³	0.0028 (hc)	20	4.7
Benzo[b]fluoranthene ^d	NC	NC	2.8x10 ⁻³	31.1x10 ⁻³	0.0028 (hc)	10	5.4
Benzo[g,h,i]perylene ^d	NC	NC	2.8x10 ⁻³	31.1x10 ⁻³	0.0028 (hc)	20	0.61
Benzo[k]fluoranthene ^d	NC	NC	2.8x10 ⁻³	31.1x10 ⁻³	0.0028 (hc)	20	0.87
alpha-BHC	*100	NC	NC	NC	0.00391 (hc)	NC	0.0385
beta-BHC	NC	NC	NC	NC	0.137 (hcc)	NC	0.024
Bis(2-chloroethyl)ether	NC	NC	**0.03	*1.36	0.0311 (hc)	10	1.9
Bis(2-chloroisopropyl)ether	NC	NC	34.7	4.36x10 ³	1,250 (h)	10	5.3

TABLE 12
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)
AND OTHER GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN: SURFACE WATER ($\mu\text{g}/\text{L}$)
TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

ANALYTE	FEDERAL SURFACE WATER QUALITY CRITERIA ($\mu\text{g}/\text{L}$)				USAEC ^a SURFACE WATER			
	FRESHWATER ACUTE CRITERIA	FRESHWATER CHRONIC CRITERIA	WATER AND FISH INGESTION	FISH CONSUMPTION ONLY	PROPOSED STATE SURFACE WATER QUALITY CRITERIA FOR FW2 WATERS	LOC ($\mu\text{g}/\text{L}$)	CRL ($\mu\text{g}/\text{L}$)	CCD ($\mu\text{g}/\text{L}$)
Bis(2-ethylhexyl)phthalate	NC	NC	NC	NC	1.76 (hc)	30	4.8	2.4
Bromodichloromethane	NC	NC	NC	NC	0.266 (hc)	5	0.59	0.295
Bromoform	NC	NC	NC	NC	4.38 (hc)	8	2.6	1.3
Bromomethane	NC	NC	NC	NC	NC	9	5.8	2.9
Butylbenzylphthalate	NC	NC	NC	NC	239 (h)	NC	3.4	1.7
Carbon tetrachloride	*35,200	NC	**0.4	**6.94	0.363 (hc)	6	0.58	0.29
Chlordane	2.4	0.0043	0.46x10 ⁻³	0.48x10 ⁻³	2.4 (a); 0.0043 (c); 0.277x10 ⁻³ (hc)	0.2	0.246	0.123
Chlorobenzene	*250	*50	NC	NC	22.0 (h)	6	0.5	0.25
Chloroform	*28,900	*1,240	0.19	15.7	5.67 (hc)	5	0.5	0.25
Chloromethane	NC	NC	NC	NC	NC	10	3.2	1.6
2-Choronaphthalene ^c	*1,600	NC	NC	NC	NC	NA	0.5	0.25
2-Chlorophenol	*4,380	*2,000	NC	NC	NC	20	0.99	0.495
Chrysene ^d	NC	NC	2.8x10 ⁻³	31.1x10 ⁻³	0.0028 (hc)	20	2.4	1.2
cis-1,3-Dichloropropene	*6,000	*244	87	14.1x10 ⁻³	0.193 (hc)	5	0.58	0.29

TABLE 12
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)
AND OTHER GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN: SURFACE WATER ($\mu\text{g}/\text{L}$)

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

ANALYTE	FEDERAL SURFACE WATER QUALITY CRITERIA ($\mu\text{g}/\text{L}$)				PROPOSED STATE SURFACE WATER QUALITY CRITERIA FOR FW2 WATERS		USAECA SURFACE WATER	
	FRESHWATER ACUTE CRITERIA	FRESHWATER CHRONIC CRITERIA	WATER AND FISH INGESTION	FISH CONSUMPTION ONLY	LOC ($\mu\text{g}/\text{L}$)	CRL ($\mu\text{g}/\text{L}$)	COD ($\mu\text{g}/\text{L}$)	
4,4'-DDD	NC	NC	NC	NC	.000832 (hc)	0.04	0.019	0.0095
4,4'-DDE	*1,050	NC	NC	NC	0.588x10 ⁻³ (hc)	0.04	0.025	0.0125
4,4'-DDT	1.1	0.001	0.024x10 ⁻³	0.024x10 ⁻³	1.1 (a); 0.001 (c); 0.588x10 ⁻³ (hc)	0.06	0.034	0.017
Di-n-butylphthalate	NC	NC	NC	NC	3,530 (h)	20	3.7	1.85
Dibenz[a,h]anthracene ^d	NC	NC	2.8x10 ⁻³	31.1x10 ⁻³	0.0028 (hc)	20	6.5	3.25
Dibromochloromethane	NC	NC	NC	NC	72.6 (h)	6	0.67	0.335
1,2-Dichlorobenzene	*1,120	*763	400	2,600	2,520 (h)	9	1.7	0.85
1,3-Dichlorobenzene ^a	*1,120	*763	400	2,600	2,620 (h)	9	1.7	0.85
1,4-Dichlorobenzene ^a	*1,120	*763	400	2,600	343 (h)	20	1.7	0.85
3,3-Dichlorobenzidine	NC	NC	**0.01	**0.02	0.0386 (hc)	60	12	6.0
1,2-Dichloroethane	*118,000	*20,000	0.94	243	0.291 (hc)	3	0.50	0.25
1,1-Dichloroethene	*11,800	NC	0.033	1.85	4.81 (hc)	6	0.50	0.25
1,2-Dichloroethene (total)	*11,800	NC	0.033	1.85	4.81 (hc)	4 (trans)	2.3	1.15
2,4-Dichlorophenol	*2,020	*365	3.09x10 ⁻³	NA	92.7 (h)	10	2.9	1.45

TABLE 12
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)
AND OTHER GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN: SURFACE WATER ($\mu\text{G/L}$)

TECHNICAL PLAN
FORT Dix RI/FS For 13 SITES

ANALYTE	FEDERAL SURFACE WATER QUALITY CRITERIA ($\mu\text{G/L}$)				USAEC ^a SURFACE WATER			
	FRESHWATER ACUTE CRITERIA	FRESHWATER CHRONIC CRITERIA	WATER AND FISH INGESTION	FISH CONSUMPTION ONLY	PROPOSED STATE SURFACE WATER QUALITY CRITERIA FOR FW2 WATERS	LOC ($\mu\text{G/L}$)	CRL ($\mu\text{G/L}$)	COD ($\mu\text{G/L}$)
1,2-Dichloropropane	*23,000	*5,700	NC	0.071x10 ⁻³	0.078x10 ⁻³	2.5 (a); 0.0019 (c); 0.135x10 ⁻³ (hc)	0.03	0.018
Dieldrin	2.5	0.0019	0.071x10 ⁻³	0.078x10 ⁻³	21,200 (h)	10	2.0	0.25
Diethylphthalate	NC	NC	350x10 ³	1.8x10 ⁶				0.009
2,4-Dimethylphenol	*2,120	NC	NC	NC	NC	NA	5.8	2.9
Dimethylphthalate	*2,120	NC	NC	NC	313,000 (h)	10	1.5	0.75
Di-n-octyl phthalate	NC	NC	NC	NC	NC	NA	15	7.5
2,4-Dinitrotoluene	NC	NC	**0.11	**9.1	0.11 (hc)	10	4.5	2.25
2,6-Dinitrotoluene	NC	NC	70	14.3x10 ³	NC	NA	0.79	0.395
Endosulfan I	0.22	0.056	74	159	0.22 (a); 0.056 (c); 0.932 (h)	NC	0.023	0.012
Endosulfan II	0.22	0.056	74	159	0.22 (a); 0.056 (c); 0.932 (h)	NC	0.023	0.012
Endosulfan sulfate	NC	NC	NC	NC	0.93 (h)	NC	0.0786	0.039
Endrin	0.18	0.0023	1	NC	0.18 (a); 0.0023 (c); 0.629 (h)	0.04	0.018	0.009

TABLE 12
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)
AND OTHER GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN: SURFACE WATER ($\mu\text{G}/\text{L}$)

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

ANALYTE	FEDERAL SURFACE WATER QUALITY CRITERIA ($\mu\text{G}/\text{L}$)				USAECA ^a SURFACE WATER			
	FRESHWATER ACUTE CRITERIA	FRESHWATER CHRONIC CRITERIA	WATER AND FISH INGESTION	FISH CONSUMPTION ONLY	PROPOSED STATE SURFACE WATER QUALITY CRITERIA FOR FW2 WATERS	LOC ($\mu\text{G}/\text{L}$)	CRL ($\mu\text{G}/\text{L}$)	
Ethylbenzene	*32,000	NC	1.4x10 ³	3.28x10 ³	3.030 (h)	6	0.5	0.25
Fluoranthene	*3,980	NC	42	54	310 (h)	10	3.3	1.65
Fluorene	NC	NC	NC	NC	1,340 (h)	10	3.7	1.85
gamma-BHC (Indane)	NC	NC	NC	NC	2.0 (a); 0.08 (c); 0.0180 (hc)	0.03	0.051	0.0255
Heptachlor	0.52	0.0038	0.28x10 ⁻³	0.28x10 ⁻³	0.52 (a); 0.0038 (c); 0.000208 (hc)	0.02	0.042	0.021
Heptachlor epoxide	NC	NC	NC	NC	0.52 (a); 0.0038 (c); 0.000208 (hc)	0.4	0.024	0.012
Hexachlorobenzene	NC	NC	0.72x10 ⁻³	0.71x10 ⁻³	0.000748 (hc)	10	1.6	0.8
Hexachlorobutadiene	*90	*9.3	**0.45	**50	6.94 (h)	10	3.4	1.7
Hexachlorocyclopentadiene	*7	*5.2	206	NC	245 (h)	10	8.6	4.3
Hexachloroethane	*980	*540	1.9	8.74	2.73 (h)	10	1.5	0.75
Indeno(1,2,3-cd)pyrene ^d	NC	NC	2.8x10 ⁻³	31.1x10 ⁻³	0.0028 (hc)	20	8.6	4.3
Isophorone	*117,000	NC	5.2x10 ³	520x10 ³	552 (h)	10	4.8	2.4
Methoxychlor	NC	0.03	100	NC	0.03 (c); 40 (h)	0.2	0.057	0.0285

TABLE 12
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)
AND OTHER GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN: SURFACE WATER ($\mu\text{g}/\text{L}$)

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

ANALYTE	FEDERAL SURFACE WATER QUALITY CRITERIA ($\mu\text{g}/\text{L}$)				PROPOSED STATE SURFACE WATER QUALITY CRITERIA FOR FW2 WATERS			USAEC ^a SURFACE WATER	
	FRESHWATER ACUTE CRITERIA	FRESHWATER CHRONIC CRITERIA	WATER AND FISH INGESTION	FISH CONSUMPTION ONLY	LOC ($\mu\text{g}/\text{L}$)	CRL ($\mu\text{g}/\text{L}$)	COD ($\mu\text{g}/\text{L}$)		
N-Nitrosodiphenylamine	NC	NC	**4.9	**16.1	4.95 (hc)	20	3.0	1.5	
Naphthalene	*2,300	*620	NC	NC	NC	NA	0.5	0.25	
Nitrobenzene	*27,000	NC	19.8x10 ³	NC	16.0 (h)	10	0.5	0.25	
2-Nitrophenol ^b	*230	*150	NC	NC	NC	NA	3.7	1.85	
Pentachlorophenol	***20	***13	1.01x10 ³	NC	0.282 (hc)	30	18.0	9.0	
Phenanthrene	NC	NC	2.8x10 ⁻³	31.1x10 ⁻³	0.0028 (hc)	10	0.5	0.25	
Phenol	*10,200	*2,560	3.5x10 ³	NC	20,900 (h)	10	9.2	4.6	
Pyrene	NC	NC	NC	NC	797 (h)	20	2.8	1.4	
1,1,2,2-Tetrachloroethane	NC	*2,400	**0.17	**10.7	1.72 (hc)	10	0.51	0.255	
Tetrachloroethylene	*5,280	*940	**0.8	**8.86	0.388 (hc)	9	1.6	0.8	
Toluene	*17,500	NC	14.3x10 ³	424x10 ³	7,440 (h)	6	0.5	0.25	
Toxaphene	0.73	0.0002	0.71x10 ⁻³	0.73x10 ⁻³	0.73 (a); 0.0002 (c); 0.73x10 ⁻³ (hc)	1	1.35	0.675	
trans-1,3-Dichloropropene	*6,000	*244	87	14.1x10 ³	0.193 (hc)	7	0.70	0.35	
1,2,4-Trichlorobenzene	NC	NC	NC	NC	30.6 (h)	10	1.8	0.9	

TABLE 12
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)
AND OTHER GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN: SURFACE WATER ($\mu\text{g}/\text{L}$)

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

ANALYTE	FEDERAL SURFACE WATER QUALITY CRITERIA ($\mu\text{g}/\text{L}$)				USAECA SURFACE WATER			
	FRESHWATER ACUTE CRITERIA	FRESHWATER CHRONIC CRITERIA	WATER AND FISH INGESTION	FISH CONSUMPTION ONLY	PROPOSED STATE SURFACE WATER QUALITY CRITERIA FOR FW2 WATERS	LOC ($\mu\text{g}/\text{L}$)	CRL ($\mu\text{g}/\text{L}$)	COD ($\mu\text{g}/\text{L}$)
1,1,1-Trichloroethane	NC	NC	18.4x10 ³	1.0x10 ⁶	127 (h)	6	0.5	0.25
1,1,2-Trichloroethane	NC	*9,400	**0.6	**41.8	13.5 (h)	6	1.2	0.6
Trichloroethene	*46,000	*21,800	**2.7	**80.7	1.09 (hc)	5	0.5	0.25
2,4,5-Trichlorophenol	NC	NC	2,800	NC	NC	10	5.2	2.6
2,4,6-Trichlorophenol	NC	*970	**1.2	**3.6	2.14 (hc)	20	4.2	2.1
Vinyl chloride	NC	NC	**2	*525	0.0830 (hc)	10	2.6	1.3
Inorganics								
Aluminum	NC	NC	NC	NC	750 (a); 87 (c)	200	141	70.5
Antimony	*9,000	*1,600	146	45,000	12.2 (h)	20	3.03	1.52
Arsenic	NC	NC	0.0022	0.0175	50 (h)	8	2.54	1.27
Barium	NC	NC	1,000	NC	1,000 (h)	20	5.0	2.5
Beryllium	*130	*5.3	0.0068	0.117	0.00767 (hc)	20	5.0	2.5
Cadmium	+3.9	+1.1	43	9.3	10 (h)	4	4.01	2.00
Chromium	+1,700	+210	170,000	3,433x10 ³	16 (a); 11 (c); 160 (h)	10	6.02	3.01

TABLE 12
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)
AND OTHER GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN: SURFACE WATER ($\mu\text{G}/\text{L}$)
TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

ANALYTE	FEDERAL SURFACE WATER QUALITY CRITERIA ($\mu\text{G}/\text{L}$)				USAEC ^a SURFACE WATER		
	FRESHWATER ACUTE CRITERIA	FRESHWATER CHRONIC CRITERIA	WATER AND FISH INGESTION	FISH CONSUMPTION ONLY	PROPOSED STATE SURFACE WATER QUALITY CRITERIA FOR FW2 WATERS	CRL ($\mu\text{G}/\text{L}$)	COD ($\mu\text{G}/\text{L}$)
Copper	+18	+12	NC	NC	$e^{(0.9422(\ln(H)-1.464)} (a)$ $e^{(0.8545(\ln(H)-1.465)} (c)$	10	8.09
Cyanide	22	5.2	200	NC	22 (a); 5.2 (c); 768 (h)	40	2.5
Iron	NC	1,000	300	NC	1,000 (c)	100	38.8
Lead	+82	+3.2	NC	60	see (A)	10	1.26
Manganese	NC	NC	50	100	100 (h)	6	2.75
Mercury	2.4	0.012	0.144	0.146	2.4 (a); 0.012 (c); 0.144 (h)	1	0.243
Nickel	+1,400	+160	13.4	100	see (B)	10	34.3
Selenium	280	35	10	NC	20 (a); 5.0 (c); 179 (h)	10	3.02
Silver	+4.1	0.12	50	NC	164 (h); see (C)	2	0.25
Sodium	NC	NC	NC	NC	400	500	250
Thallium	*1,400	*40	13	48	1.70 (h)	10	6.99
Zinc	+120	+110	NC	NC	see (D)	30.09	21.1
							10.6

Notes:

- + = Hardness Dependent Criteria (100 mg/L used)
- * = Insufficient Data to Develop Criteria Value presented is the harvest Observed Effect Level (LOEL)
- ** = Human Health Criteria for Carcinogens Reported for Three Risk Levels Value Presented is 10^6 Risk Level
- *** = pH Dependent Criteria (7.8 pH used)
- LOC = Level of Concern. Defined as the NJDEPE Surface Water PQLs, unless otherwise noted. NJDEPE Surface Water PQLs from N.J.A.C. 7:9-4, New Jersey's Surface Water Quality Standards, NJDEPE, October 1992. For inorganics, the "natural background" concentrations will also be considered for LOCs. "Natural inorganic background" concentrations will be established from analytical results from background samples and published regional background data.
- PQL = Practical Quantitation Level
- NC = No Criterion
- NA = Not Available
- (a) = aquatic protection based criteria
- (h) = criteria based upon human health information
- a+ = criteria developed after review of both human health information and aquatic protection data. The basis for the criterion adopted (human health or aquatic protection) is indicated by the letter preceding the *.
- h+ = criteria developed after review of both human health information and aquatic protection data. The basis for the criterion adopted (human health or aquatic protection) is indicated by the letter preceding the *.

see p. 56 of NJ SW reg for hc and hcc "H" represents hardness in mg/L as calcium carbonate in water quality criteria formulas for metals.

Except as noted, aquatic life criteria followed by an (a) represent acute aquatic life protection criteria as a one-hour average, aquatic life criteria followed by (c) represent chronic aquatic life protection criteria as a four-day average. No exceedance of aquatic life criteria shall be permitted at or above the design flows specified in section N.J.A.C. 7:9B-1.5(c)2. Criteria followed by an (h) are noncarcinogenic effect-based human health criteria as a 30-day average with no frequency of exceedance at or above the design flows specified in section N.J.A.C. 7:9B-1.5(c)2. Criteria followed by (hc) are carcinogenic effect-based human health criteria as a 70-year average with no frequency of exceedance at or above the design flows specified in section N.J.A.C. 7:9B01.5(c)2 and are based on a risk level of one-in-one-million. Criteria followed by (hcc) are for toxic substances considered to be possible human carcinogens and are based on a risk level of one-in-one hundred thousand. These criteria, (hc) and (hcc), are carcinogenic effect-based human health criteria as a 70-year average with no frequency of exceedance at or above the design flows specified in section N.J.A.C. 7:9B-1.5(c)2. Criteria followed by an (O_L) are organoleptic effect-based criteria and are maximum concentrations. "H" represents hardness, in mg/L as calcium carbonate, in water quality criteria formulas for metals.

- (a) Federal criteria are for total dichlorobenzenes
- (b) Federal criteria are for nitrophenols
- (c) Federal criteria are for chlorinated naphthalenes
- (d) Federal criteria are for total carcinogenic PAHs
- (e) Federal and State criteria are for total PCBs

$$e^{(1.273(\ln H - 1.160)} (a), e^{(1.273(\ln H - 4.705)} (c); 5(h)$$

$$e^{(0.8460(\ln H) + 3.3612} (a); e^{(0.8460(\ln H) + 1.1645)} (c); 516(h)$$

$$e^{(1.72(\ln H) - 8.52)} (a)$$

$$e^{(0.8473(\ln H) + 0.8864)} (a); e^{(0.8473(\ln H) + 0.7814)} (c)$$
- (D)

TABLE 13
SEDIMENT QUALITY CRITERIA FOR SELECTED ORGANIC COMPOUNDS

**TECHNICAL PLAN
 FORT DIX RI/FS FOR 13 SITES**

COMPOUND	SEDIMENT CRITERION ($\mu\text{g/g}$ CARBON) (TOP # FW CRITERION, BOTTOM # SW CRITERION)		
	95% CONFIDENCE INTERVAL		
	MEAN	LOWER	UPPER
Acenaphthene	730 NA	180 NA	3,030 NA
Anilene	0.0662 0.248	0.0169 0.0635	0.262 0.984
Chlorpyrifos	3.22 0.44	0.831 0.114	12.7 1.73
DDT	0.828 0.828	0.183 0.183	3.80 3.80
Dieldrin	0.130 0.130	0.00976 0.00976	1.79 1.79
Endrin	0.0532 0.0532	0.00654 0.00654	0.443 0.443
Ethyl Parathion	0.0810 NA	0.0160 NA	0.416 NA
Heptachlor	0.110 0.104	0.0148 0.014	0.840 0.796
Lindane	0.157 NA	0.0394 NA	0.636 NA
Phenanthrene	139 102	32.6 23.8	605 442

Notes:

* should be used as a surrogate for PCBs in general

FW = fresh water

SW = salt water

NA = not available

The sediment quality criteria are reference numbers used to identify the presence of contamination exceeding levels potentially harmful to aquatic life. Specific cleanup objectives are to be developed on a case-by-case basis.

TABLE 14
SCREENING LEVEL VALUES FOR INORGANICS, PESTICIDES, AND PAHS IN SEDIMENT

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

CHEMICAL ANALYTE	ER-L CONCENTRATION	ER-M CONCENTRATION	SUBJECTIVE DEGREE OF CONFIDENCE IN ER-L/ER-M VALUES
Trace Elements (ppm)			
Antimony	2	25	Moderate/moderate
Arsenic	33	85	Low/moderate
Cadmium	5	9	High/high
Chromium	80	145	Moderate/moderate
Copper	70	390	High/high
Lead	35	110	Moderate/high
Mercury	0.15	1.3	Moderate/high
Nickel	30	50	Moderate/moderate
Silver	1	2.2	Moderate/moderate
Zinc	120	270	High/high
Pesticides (ppb)			
Chlordane	0.5	6	Low/low
Polynuclear Aromatic Hydrocarbons (ppb)			
Acenaphthene	150	650	Low/low
Anthracene	85	960	Low/moderate
Benzo(a)anthracene	230	1,600	Low/moderate
Benzo(a)pyrene	400	2,500	Moderate/moderate
Chrysene	400	2,800	Moderate/moderate
Dibenz(a,h)anthracene	60	260	Moderate/moderate
Fluoranthene	600	3,600	High/high
2-methylnaphthalene	65	670	Low/moderate
Naphthalene	340	2,100	Moderate/high
Phenanthrene	225	1,380	Moderate/moderate
Pyrene	350	2,200	Moderate/moderate
Total PAH	4,000	35,000	Low/low

Notes:

The ER-L and ER-M are reference numbers used to identify the presence of contamination exceeding levels potentially harmful to aquatic life. Specific cleanup objectives are to be developed on a case-by-case basis.

Source: NOAA 1990

TABLE 15
PROPOSED SOIL CLEANUP CRITERIA

**TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES**

Contaminant	CASRN	RESIDENTIAL DIRECT CONTACT SOIL CLEANUP CRITERIA (a)(b) (mg/kg)	NON RESIDENTIAL DIRECT CONTACT SOIL CLEANUP CRITERIA (a)(b) (mg/kg)	IMPACT TO GROUNDWATER SOIL CLEANUP CRITERIA(b) (mg/kg)
Acenaphthene	83-32-9	3,400	10,000(c)	100
Acetone	67-64-1	1,000(d)	1,000(d)	100(i)
Acrylonitrile	107-13-1	1	5	1(i)
Aldrin	309-00-2	0.040	0.17	50
Anthracene	120-12-7	10,000(c)	10,000(c)	100(i)
Antimony	7440-36-0	14	340	(h)
Arsenic	7440-38-2	20(e)	20(e)	(h)
Barium	7440-39-3	700	47,000(n)	(h)
Benzene	71-43-2	3	13	1
3,4-Benzofluoranthene-(Benzo(b)fluoranthene)	205-99-2	0.9	4	50(i)
Benzo(a)anthracene	56-55-3	0.9	4	500
Benzo(a)pyrene (BaP)	50-32-8	0.66(f)	0.66(f)	100
Benzo(k)fluoranthene	207-08-9	0.9	4	500
Benzyl Alcohol	100-51-6	10,000(c)	10,000(c)	50
Beryllium	7440-41-7	1(f)	1(f)	(h)
Bis(2-chloroethyl)ether	111-44-4	0.66(f)(i)	3	10(j)
Bis(2-chloroisopropyl)ether	39638-32-9	2,300	10,000(c)	10
Bis(2-ethylhexyl)phthalate	117-81-7	49	210	100
Bromodichloromethane (Dichlorobromomethane)	75-27-4	11(g)	46(g)	1
Bromoform	75-25-2	86	370	1
Bromomethane	74-83-9	79	1,000(d)	1
2-Butanone (MEK)	78-93-3	1,000(d)	1,000(d)	50
Butylbenzyl phthalate(j)	85-68-7	1,100	10,000(c)	100
Cadmium	7440-43-9	1	100	(h)
Carbon tetrachloride	56-23-5	2(k)	4(k)	(r)
4-Chloroaniline	106-47-8	230	4,200	(h)
Chlorobenzene	108-90-7	37	680	1
Chloroform	67-66-3	19(k)	28(k)	1

TABLE 15
PROPOSED SOIL CLEANUP CRITERIA

**TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES**

Contaminant	CASRN	RESIDENTIAL DIRECT CONTACT SOIL CLEANUP CRITERIA (a)(b) (mg/kg)	NON RESIDENTIAL DIRECT CONTACT SOIL CLEANUP CRITERIA (a)(b) (mg/kg)	IMPACT TO GROUNDWATER SOIL CLEANUP CRITERIA(b) (mg/kg)
4-Chloro-3-methyl phenol (p-Chloro-m-cresol)	59-50-7	10,000(c)	10,000(c)	100
Chloromethane	74-87-3	520	1,000(d)	10
2-Chlorophenol	95-57-8	280	5,200	10(j)
Chrysene	218-01-9	9	40	500
Copper	7440-50-8	600(m)	600(m)	(h)
Cyanide	57-12-5	1,100	21,000(o)	(h)
4,4'DDD (p,p'-TDE)	72-54-8	3	12	50(i)
4,4'-DDE	72-55-9	2	9	50(i)
4,4'-DDT	50-29-3	2	9	500(i)
Dibenz(a,h)anthracene	53-70-3	0.66(f)	0.66(f)	100(j)
Dibromochloromethane (Chlorodibromomethane)	124-48-1	110	1,000(d)	1
Di-n-butyl phthalate	84-74-2	5,700	10,000(c)	100
Di-n-octyl phthalate	117-84-0	1,100	10,000(c)	100
1,2-Dichlorobenzene	95-50-1	5,100	10,000(c)	50
1,3-Dichlorobenzene	541-73-1	5,100	10,000(c)	100
1,4-Dichlorobenzene	106-46-7	570	10,000(c)	100
3,3'-Dichlorobenzidine	91-94-1	2	6	100
1,1-Dichloroethane	75-34-3	570	1,000(d)	10(i)
1,2-Dichloroethane	107-06-2	6	24	1
1,1-Dichloroethene	75-35-4	8	150	10
1,2-Dichloroethene (trans)	156-60-5	1,000(d)	1,000(d)	50
1,2-Dichloroethene (cis)	156-59-2	79	1,000(d)	1(i)
2,4-Dichlorophenol	120-83-2	170	3,100	10
1,2-Dichloropropane	78-87-5	10	43	(r)
1,3-Dichloropropene (cis and trans)	542-75-6	4	5(k)	1
Dieldrin	60-57-1	0.042	0.18	50
Diethyl phthalate	84-66-2	10,000(c)	10,000(c)	50

TABLE 15
PROPOSED SOIL CLEANUP CRITERIA

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

Contaminant	CASRN	RESIDENTIAL DIRECT CONTACT SOIL CLEANUP CRITERIA (a)(b) (mg/kg)	NON-RESIDENTIAL DIRECT CONTACT SOIL CLEANUP CRITERIA (a)(b) (mg/kg)	IMPACT TO GROUNDWATER SOIL CLEANUP CRITERIA(b) (mg/kg)
2,4-Dimethyl phenol	105-67-9	1,100	10,000(c)	10
Dimethyl phthalate	131-11-3	10,000(c)	10,000(c)	50
Dinitrotoluene (2,4-/2,6-mixture)	25321-14-6	1(l)	4(l)	10(l)
2,4-Dinitrophenol	51-28-5	110	2,100	10
Endosulfan	115-29-7	340(g)	6200(g)	50
Endrin	72-20-8	17	310	50
Ethylbenzene	100-41-4	1,000(d)	1,000(d)	100
Fluoranthene	206-44-0	2,300	10,000(c)	100(i)
Fluorene	86-73-7	2,300	10,000(c)	100
Heptachlor	76-44-8	0.15	0.65	50(j)
Hexachlorobenzene	118-74-1	0.66(f)	2	100(i)
Hexachlorobutadiene	87-68-3	1(g)	21(g)	100(g)
Hexachlorocyclopentadiene	77-47-4	400	7,300	100
Hexachlorethane	67-72-1	6	100	100
Indeno(1,2,3-cd)pyrene	193-39-5	0.9	4	500
Isophorone	78-59-1	1,100	10,000(c)	50(j)
Lead	7439-92-1	100(p)	600(q)	(h)
Lindane	58-89-9	0.52	2.2	50(j)
2-Methylphenol	95-48-7	2,800	10,000(c)	(r)
4-Methylphenol	106-44-5	2,800	10,000(c)	(r)
Methoxychlor	72-43-5	280	5,200	50(i)
Mercury	7439-97-6	14	270	(h)
4-Methyl-2-pentanone (MIBK)	108-10-1	1,000(d)	1,000(d)	50
Methylene chloride	75-09-2	49	210	1(l)
Naphthalene(j)	91-20-3	230	4,200	100
Nickel	7440-02-0	250	2,400(k)(n)	(h)
Nitrobenzene	98-95-3	28	520	10(l)
N-Nitrosodiphenylamine	86-30-6	140	600	100

TABLE 15
PROPOSED SOIL CLEANUP CRITERIA

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

Contaminant	CASRN	RESIDENTIAL DIRECT CONTACT SOIL CLEANUP CRITERIA (a)(b) (mg/kg)	NON RESIDENTIAL DIRECT CONTACT SOIL CLEANUP CRITERIA (a)(b) (mg/kg)	IMPACT TO GROUNDWATER SOIL CLEANUP CRITERIA(b) (mg/kg)
N-Nitrosodi-n-propylamine	621-64-7	0.66(f)	0.66(f)	10(j)
PCBs (Polychlorinated biphenyls)	1336-36-3	0.49(i)	2	50(i)
Pentachlorophenol	87-86-5	6	24	100
Phenol	103-95-2	10,000(c)	10,000(c)	50
Pyrene	129-00-0	1,700	10,000(c)	100(j)
Selenium	7782-49-2	63	3,100(n)	(h)
Silver	7440-22-4	110(g)	4,100(n)	(h)
Styrene	100-42-5	23	97	100
1,1,1,2-Tetrachloroethane	630-20-6	170	310	1
1,1,2,2-Tetrachloroethane	78-34-5	34	70(k)	1
Tetrachloroethylene	127-18-4	4(k)	6(k)	1
Thallium	7440-28-0	2(f)	2(f)	(h)
Toluene	108-88-3	1,000(d)	1,000(d)	500
Toxaphene	8001-35-2	0.10(k)	0.2(k)	50(i)
1,2,4-Trichlorobenzene	120-82-1	68	1,200	100
1,1,1-Trichloroethane	71-53-6	210	1,000(d)	50
1,1,2-Trichloroethane	79-00-5	22	420	1
Trichloroethene (TCE)	79-01-6	23	54(k)	1
2,4,5-Trichlorophenol	95-95-4	5,600	10,000(c)	50
2,4,6-Trichlorophenol	88-06-2	62	270	10(i)
Vanadium	7440-62-2	370	7,100(h)	(h)
Vinyl chloride	75-01-4	2	7	10(i)
Xylenes (Total)	1330-29-7	410	1,000(d)	10
Zinc	7440-66-6	1,500(m)	1,500(m)	(h)

Notes:

Source: NJDEPE Soil Cleanup Criteria (Last Revised 2/3/94)

- (a) Criteria are health based using an incidental ingestion exposure pathway except where noted below.
- (b) Criteria are subject to change based on site specific factors (e.g., aquifer classification, soil type, natural background, environmental impacts, etc.).
- (c) Health based criterion exceeds the 10,000 mg/kg maximum for total organic contaminants.
- (d) Health based criterion exceeds the 1,000 mg/kg maximum for total volatile organic contaminants.

- (e) Cleanup standard proposal was based on natural background.
- (f) Health based criterion is lower than analytical limits; cleanup criterion based on practical quantitation level.
- (g) Criterion has been recalculated based on new toxicological data.
- (h) The impact to groundwater values for inorganics will be developed based upon site-specific chemical and physical parameters.
- (i) Original criterion was incorrectly calculated; new criterion recalculated using original toxicological data.
- (j) Typographical error.
- (k) Criterion based on inhalation exposure pathway which yielded a more stringent criterion than the incidental ingestion exposure pathway.
- (l) Criterion derived in the basis and background document but inadvertently omitted from Table 3-1 for the residential standard and Table 7-1 for the non-residential standard as found in the proposed rule.
- (m) Criterion based on ecological (phytotoxicity) effects.
- (n) Level of the human health based criterion is such that evaluation for potential environmental impacts on a site-by-site basis is recommended.
- (o) Level of the criterion is such that evaluation for potential acute exposure hazard is recommended.
- (p) Criterion based on the goal that children should be exposed to the minimal amount of lead that is practicable and is reflective of natural background as altered by diffuse anthropogenic pollution. Criterion corresponds to both a median value for urban land which has not been impacted by any local point source of lead and a 90th percentile value for similar suburban land.
- (q) Criteria were derived from a model developed by the Society for Environmental Geochemistry and Health (SEGH) and was designed to be protective for adults in the workplace.
- (r) Insufficient information available to calculate impact to groundwater criteria.